

FINAL RELEASE

PUBLIC HEALTH ASSESSMENT

**MARINE CORPS COMBAT DEVELOPMENT COMMAND
(MCCDC) QUANTICO,
PRINCE WILLIAM COUNTY, VIRGINIA
EPA FACILITY ID: VA1170024722**

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Prepared by:

Federal Facilities Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Foreword

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Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Child Development Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CREG	ATSDR's Cancer Risk Evaluation Guide
CV	Comparison value
DOD	Department of Defense
DON	Department of the Navy
EMEG	Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
Kg	kilogram(s)
IAS	Initial assessment study
IRP	Installation restoration program
FFA	Federal Facilities Agreement
FRR	Former Rifle Range
ICPRB	Interstate Commission on the Potomac River Basin
MCB	Marine Corps Base
MCCDC	Marine Corps Combat and Development Command
MCL	EPA's maximum contaminant level
mg	milligram(s)
mg/kg	milligram(s) per kilogram
mg/kg/day	milligram(s) per kilogram of body weight per day
Φg	microgram(s)
Φg/dl	micrograms per deciliter
Φg/m ³	microgram(s) per cubic meter
MRL	ATSDR's minimal risk level
NACIP	Navy assessment and control of installation pollutants
NOV	Notice of Violation
NPDES	National Permit Discharge Elimination System
NPL	National Priorities List
NRMD	Natural Resources Management Division
PCB	Polychlorinated biphenyl
PHA	Public Health Assessment
PHAP	Public Health Action Plan
ppb	Part(s) per billion

Abbreviations

ppm	Part(s) per million
PPV	Public-Private Venture
QPMT	Quantico project managers team
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
SMP	Site management plan
SVOC	Semi-volatile Organic Compound
VDEQ	Virginia Department of Environmental Quality
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VOC	Volatile Organic Compound

I. Summary

The Marine Corps Combat Development Command (MCCDC Quantico) is an active base in Virginia covering approximately 60,000 acres bordering three counties: Prince William, Stafford, and Fauquier. The base is 35 miles south of Washington D.C. and 75 miles north of Richmond, Virginia. The base is divided into two sections, the Mainside Area (most developed section) and the Guad area (combined training areas). A section of the eastern border of the base forms the Quantico Embayment of the Potomac River. Since the base was permanently established in 1918, MCCDC Quantico (MCCDC Quantico will be referred to as MCCDC Quantico throughout this report) has been used to train Marine Corps and Federal Bureau of Investigation (FBI) personnel, as well as for the research, development, and testing of military equipment. Environmental contamination has been identified in a number of locations on site during environmental investigations that have been conducted as part of the Department of the Navy's (DON) requirements for performing hazardous waste assessments.

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted an initial site visit of Quantico in 1994. The purpose of the site visit was to collect information that would assist ATSDR in prioritizing MCCDC Quantico designated sites according to their potential public health hazard. ATSDR conducted a follow up site visit to MCCDC Quantico in February 2003. During this visit ATSDR met with MCCDC Quantico, Department of the Navy (DON), and U.S. Environmental Protection Agency (EPA) representatives, was briefed on the current status of MCCDC Quantico's environmental investigations and remedial activities, and conducted a site tour. ATSDR provided an overview of its health assessment process, and discussed the exposure situations identified during the site visit.

This public health assessment (PHA) presents ATSDR's evaluation of three exposure situations identified at MCCDC Quantico.

Exposure Situations Identified at MCCDC Quantico

1. *Potential exposure to lead in surface soil of the Former Firing Range*
2. *Potential exposure to asbestos and lead in family housing*
3. *Contamination in the Quantico Embayment and other surface water features abutting Quantico from the Old Landfill (Site 4) and other source areas*

To prepare this PHA, ATSDR reviewed available environmental sampling data from MCCDC Quantico, the Virginia Department of Environmental Quality (VDEQ), and the US Fish and Wildlife Service (USFWS). ATSDR also consulted with representatives from the DON's Environmental Health Center (NEHC), base personnel, and regulatory agency officials about environmental and public health issues and community concerns associated with the base. ATSDR's conclusions related to the three potential exposure situations follows and are also summarized in Table 1 at the end of section III of this report.

1. ***Potential exposure to lead in surface soil of the Former Rifle Range (FRR):*** The FRR is approximately 51 acres in size and is the location of between 10 and 15 former firing range areas, consisting of pistol, rifle, and skeet ranges. The FRR was used from the mid-1930s through the mid-1960s. As a result of activities associated with the FRR, lead and other site-related contaminants have impacted surface and subsurface soil. Elevated concentrations of lead are present in berms and downrange locations from projectiles fired at each of the known ranges. Elevated concentrations of lead have also been detected along the firing line.

ATSDR evaluated data collected by DON contractors and general information about the site. Lead was detected in surface soil above EPA's recommended clean-up level for residential soil in each of the ranges except for Range E. During the site visit, ATSDR noticed that the fence near the base housing area (Argonne Hills) was damaged. However, MCCDC Quantico representatives clarified that this is the Argonne Hills

Housing fence and that there is a newer fence that surrounds the FRR and is completely in tact with signs posted along the fence warning of potential lead hazards at the FRR. In addition, most of the former range area is vegetated further reducing the potential for exposure in situations where trespassers gain access to the site. A removal action, which is scheduled to take place during 2004, will further eliminate potential sources of exposure at the FRR. ATSDR concludes that lead in soil at the FRR is not a past, current or future health hazard.

2. **Potential exposure to lead and asbestos in family housing:** Current and future exposures to asbestos and lead in family housing do not pose a public health hazard. Lead screening in children is routinely conducted at MCCDC Quantico and there have been no cases of elevated blood lead (i.e., blood lead levels above 10 ug/dl) identified in children living on base. The MCCDC Quantico housing office distributes information about lead hazards and provides educational materials about how to reduce potential exposures to lead. As part of the PPV for new housing at MCCDC Quantico, a large portion of the old housing is being replaced with new or renovated housing. This will eliminate any potential hazards in the future for children living in on-base housing.

It is unknown whether past exposures to asbestos or lead in family housing were a health hazard. Past exposure exposures to lead-based paint were possible. Due to the lack of sampling data it is unknown whether past exposure to asbestos occurred. Since information is not currently available to evaluate this past exposure, it is considered an indeterminate public health hazard.

3. **Contamination in the Quantico Embayment area:** The largest source of contamination identified at MCCDC Quantico is the Old Landfill (Site 4). This inactive landfill is a 24-acre site located on the banks of the Potomac River in the Mainside Area of the base. During its period of operation, the landfill received waste and debris materials associated with base activities. Electrical transformers were stored at the site and PCBs were released into the environment (e.g., the soil and sediment). MCCDC Quantico has been

listed on the Environmental Protection Agency's (EPA's) National Priorities List because of contamination associated with the Old Landfill. Contaminants, most notably PCBs and pesticides (i.e., DDT and associated metabolites), from the Old Landfill have migrated to the Quantico Embayment, an inlet of the Potomac River, resulting in contamination of sediment, fish, and shellfish.

In 1992, VDEQ conducted fish and invertebrate sampling in the Potomac River adjacent to the Old Landfill. The maximum PCB concentration reported during this sampling effort was 1.9 parts per million (ppm) wet weight in a whole body sample of sunfish. On the basis of the high concentrations of PCBs detected in biota, VDEQ issued a Notice of Violation to MCCDC Quantico in the spring of 1993. Additional fish and invertebrate sampling conducted between 1993 and 1995 revealed PCB concentrations that exceeded FDA's tolerance level of 2 parts per million (the tolerance level is intended for PCBs detected in commercially sold edible fish and shellfish tissue). The analyses of contaminants in fish showed that the highest levels of PCBs and pesticide residues were detected in carp samples collected from the Quantico Embayment. Aroclor 1260 was detected in a carp sample at 3.5 ppm. A metabolite of DDT (4,4'-DDD) was also detected as high as 9.7 ppm, which is above FDA's tolerance level of 5 ppm for DDT compounds in commercially sold fish and shellfish tissue

ATSDR released a Health Consultation in February 1996 to evaluate potential public health concerns associated with exposure to PCBs and DDT (and its metabolites) from consuming fish from contaminated portions of the Quantico Embayment of the Potomac River. ATSDR concluded that consumption of fish and shellfish from the Quantico Embayment does not pose a health concern for the general public. The Virginia Department of Health (VDH) has closed the area around Quantico Embayment to clam and oyster harvesting due to high bacteria levels found in these shellfish. Other advisories, as noted below, are for chemical contaminants found in fish.

ATSDR believes that local consumption of most edible fish from the Quantico Embayment does not pose a public health hazard for people who recreationally fish and occasionally

consume their catch (i.e., eat 6 [8 ounce] fish meals or fewer per year from the Quantico Embayment). People who eat carp and Channel catfish from the Quantico Embayment should limit consumption of these two species to 3 or 4 meals per year. Although not all common edible species have been sampled from the Quantico Embayment, it is likely that carp and catfish are among the most contaminated species because they feed on the bottom where the highest concentrations of PCB-contaminated sediments and biota typically occur.

There is a lack of information about the fish consumption patterns of anglers who may be collecting and consuming fish from the embayment in amounts higher than the general population. The extent to which specific groups in the community (e.g., anglers or ethnic sub-populations [e.g., Hispanics or Vietnamese]) consume fish from the Quantico Embayment and other contaminated waters near MCCDC Quantico is unknown. The VDH issued a fish consumption advisory for PCBs in April 1999. The advisory includes portions of the Potomac River and tributaries near MCCDC Quantico. The health department's fish consumption advisory is limited to one fish species (Channel catfish) greater than 18 inches in length. VDH's advisory specifically recommends eating no more than one (8 oz) meal of channel catfish per month. The current advisory may not adequately protect some anglers or other populations who routinely (e.g. more than one [8 oz] fish meal per month) consume higher amounts of catfish and other fish species from the embayment area.

ATSDR is unable to make a public health determination regarding subpopulations (e.g., subsistence fishers) in the vicinity of the installation that may catch and consume fish in excess of the amounts and variety of fish in the current state consumption advisory. Until additional sampling data is collected for other common edible species (e.g., bass or trout) and more is known about the fishing consumption patterns of anglers and any subsistence fishers in the area, ATSDR considers the public health hazard designation for this subpopulation as indeterminate. People who fish in the Quantico Embayment should follow the recommended safe fish consumption guidelines presented in Table 7 of this report (refer also to ATSDR's 1996 Health Consultation located in Appendix E).

ATSDR also evaluated the potential for people who hunt at MCCDC Quantico to be exposed to site-related contaminants in game animals (this evaluation was presented in ATSDR's community concerns section). The base supports a large and diverse wildlife population (e.g., ducks, geese, deer, turkey). MCCDC Quantico has not conducted any testing of such wildlife, however, only small portions of the base contain contaminants that would be likely to accumulate in wildlife. Additionally, there is no evidence that hunters at MCCDC Quantico rely on game meat for anything more than an occasional meal (e.g., a few times per year). Therefore, *ATSDR believes that it is very unlikely that consumption of most species of wildlife at MCCDC Quantico would pose a public health hazard.* Studies at other contaminated sites have shown that certain types of wildlife can accumulate contaminants, especially in fatty tissues and the liver. Therefore, as an added precaution to minimize any exposure to contaminants that typically accumulate in wildlife, *ATSDR recommends removing the skin, trimming fat, and avoiding organ meats such as the liver and kidney in game animals.*

II. Background

1. Site Description and Operational History

The Marine Corps Combat Development Command (MCCDC) Quantico (referred to as MCCDC Quantico throughout this report) is an active duty base located 35 miles south of Washington D.C. and 75 miles north of Richmond, Virginia. The base covers more than 60,000 acres in southern Prince William County, northern Stafford County, and eastern Fauquier County (Figure 1). The eastern border of the base forms the Quantico Embayment of the Potomac River (ATSDR 1994; Tetra Tech 2000a).

Cedar Run and Virginia State Route 646 bound the base to the north, to the east by the Potomac River, to the south by Tank Creek, Aquia Creek, and Virginia State Route 610, and to the west by Darrel's Run and Virginia State Route 612. MCCDC Quantico restricts access to the eastern side of the Base (Mainside Area) via a fence. Non-military personnel must pass through security checks entering the Mainside Area gate (Fuller Road and Russel Road). As a result of terrorist activity, all unauthorized personnel must pass through security checks to enter any portion of the base. The entire base is patrolled by Military Police (Tetra Tech 2000b; Major R. Schilke, Deputy, Natural Resources and Environmental Affairs Branch, MCCDC Quantico, Personal Communications, December 9, 2003).

The base is divided into two sections, the Mainside Area, located east of Interstate Route 1-95, and the combined training areas (Guad Area), located west of 1-95 (Figure 2). The Mainside Area is the most developed portion of the base containing the headquarters, housing, storage and supply units, administrative offices, three training areas, and other facilities. The Guad Area contains 13 training areas including small arms, grenade, rocket, machine gun, and artillery ranges (Tetra Tech 2003a).

In 1917, 5,300 acres of land adjacent to the Potomac River near MCCDC Quantico were leased by the U.S. Department of Defense (DOD) to establish a new Marine Corps training camp. In

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July 1918, the Marine Corps Air Station (MCAS) began operations at MCCDC Quantico. In December 1918, the leased land was purchased, and Quantico Marine Corps Base (MCB) was permanently established. In April 1943, 50,985 acres of land west of Route 1 was obtained to accommodate increased training activities. On January 1, 1968, the Quantico Marine Corps Base changed its title and was re-designated the Marine Corps Development and Education Command. In November 1987, the base was renamed MCCDC Quantico (Tetra Tech 1999). The principal missions of the activity include training of Marine Corps and Federal Bureau of Investigation (FBI) personnel, as well as research, development, and testing of military equipment (Tetra Tech 2000a). MCCDC is now the major command aboard MCCDC Quantico; however, the land and all facilities are referred to as MCCDC Quantico.

2. Remedial and Regulatory History

An Initial Assessment Study (IAS) was completed in March 1984 for MCCDC Quantico as part of the Department of Defense's Installation Restoration Program (IRP). The purpose of the IAS was to identify and assess sites that posed a potential threat to human health or the environment as a result of residual contamination from past hazardous material operations (Tetra Tech 2002). Based on information from historical records, aerial photographs, field inspections, and personnel interviews, a total of 17 potentially contaminated sites were identified during the IAS at MCCDC Quantico. The IAS team concluded that six of the seventeen IRP sites might pose a potential exposure hazard. The six sites were recommended for the next phase, a confirmation study, under the Navy Assessment and Control of Installation Pollutants (NACIP) Program. One additional site, site number 2 {Asbestos Burial Area}, was recommended for further action (Hart Associates 1984).

The six IRP sites initially recommended for additional evaluation were:

- (1) Pesticide Burial Area (Site 1);
- (2) Old Landfill (Site 4);
- (3) Old Batch Plant (Site 5);

- (4) Recently Closed Landfill (Site 7);
- (5) Battery Acid Disposal Area (Site 13); and
- (6) Arsenic Disposal Area (Site 17).

In June 1986, a draft confirmation study was completed for 7 IRP sites. Prior to the start of this confirmation study, site investigators removed one of the original six sites (Site 13) and added two additional sites. Two more sites were added to the IRP listing after preliminary RI's were completed for each of the 7 IRP sites included in the confirmation study. These 4 additional sites include:

- (1) Brown Field Underground Fuel Storage Area (USFA) (Site 6);
- (2) Aero Club [Site 18];
- (3) Former Fire Training Area [Site 19]); and
- (4) Former Rifle Range (FRR) (Site 20)

Appendix A provides a description of each of these sites along with corresponding investigations, corrective activity, and ATSDR's public health hazard determination (Radian 1987). Figure 3 shows the location of the sites.

Three primary areas where environmental contamination had initially been identified on base include the Old Landfill (Site 4), the FRR (Site 20), and the Pesticide Burial Area (Site 1). The Old Landfill and FRR are discussed in detail in this report. ATSDR did not identify a completed exposure pathway at the Pesticide Burial Area and the contamination associated with this site was removed in January 1974. Additional information regarding the Pesticide Burial Area can be found in Appendix A.

MCCDC QUANTICO has been listed on the Environmental Protection Agency (EPA) National Priorities List (NPL) because of contamination associated with the Old Landfill. Contaminants from the Old Landfill have migrated to the Quantico Embayment, resulting in contamination of sediment, fish and shellfish. In June 1993, the Virginia department of Environmental Quality (VDEQ) issued a notice of violation (NOV) for the discharge of contaminants to state waters

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without authority of a National Pollutant Discharge Elimination System permit. This discharge of contaminants resulted in a violation of water quality standards for surface water and groundwater. MCCDC Quantico was proposed for the NPL on May 10, 1993 and was placed on EPA's NPL on June 30, 1994 (US Navy 2003).

In response to the November 1993 NOV, the DON initiated measures to reduce the impact of site-related contaminants in the nearby aquatic environment. In July 1995, MCCDC Quantico held a public meeting to present the results of the focused feasibility study (FFS) for the Old Landfill and the proposed plan identifying the DON's preferred interim remedy. The DON and USEPA Region III signed a Federal Facilities Agreement (FFA) in February 1999. Soon after the FFA was finalized, a partnering team (including the DON, EPA, and VDEQ) referred to as the Quantico Project Managers Team (QPMT) was established (US Navy 2003).

Since the IRP process began, 226 sites have been identified at MCCDC Quantico. As of March 2003, the QPMT has completed IRP investigations at 204 sites, and site investigations are currently being conducted at the 22 remaining sites. One hundred ninety-five of the 204 sites that were investigated have been closed with no further action. Environmental investigations at nine sites were deferred to other regulatory programs (Tetra Tech. 2003).

3. ATSDR Involvement

ATSDR conducted an initial site visit of MCCDC Quantico from October 25-27, 1994. The purpose of the site visit was to collect information that would assist ATSDR in prioritizing MCCDC Quantico designated sites according to their potential public health hazard. During the initial scoping visit, ATSDR staff met with MCCDC Quantico personnel and contacted representatives from federal and state agencies.

Shortly after the October site visit ATSDR provided preliminary findings in a site summary report (Appendix G). The report identified four public health concerns associated with activities at MCCDC Quantico. The concerns included: 1) possible sources of contamination (e.g., Old Landfill [Site 4], Fire Training Area [Site 19], and FRR [Site 20]) that may have impacted the

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Chopawamsic Creek and other portions of the Quantico Embayment area; 2) the potential for metal debris and unmarked drums scattered throughout the Old Landfill to present physical hazards; 3) concerns that lead-contaminated soil at the FRR may pose a health hazard for children who were able to access the site; and 4) the potential for groundwater contamination from the Pesticide Burial Area to impact the Ponderosa Pond.

ATSDR provided recommendations for each of the four health concerns identified. Specifically, it was recommended that 1) MCCDC Quantico ensure that future sampling efforts are appropriate to fulfill EPA and ATSDR's data needs and that MCCDC Quantico gather information about fish consumption rates and fishing locations; 2) signs be posted warning of the potential site hazards (i.e., chemical contamination and any physical hazards); 3) additional signs warning residents about lead contamination be placed along the fence lines at the FRR facing the base housing area and educational materials regarding the hazards associated with the site be distributed to residents of on-base housing; and 4) the hydrology near the Pesticide Burial Area be characterized to investigate the potential for groundwater to contaminate Ponderosa Pond and determine whether people are fishing from the pond.

During the follow-up site visit ATSDR concluded that physical hazards at the Old Landfill are not a significant concern since remedial activities conducted in 1997 eliminated most waste materials along the embayment shoreline and a fence was installed around the perimeter. ATSDR also reevaluated the potential for exposures to occur from fishing at Ponderosa Pond. On the basis of information from MCCDC Quantico personnel, ATSDR concluded that the pond is not a popular fishing location. In addition, since the source of contamination has been removed, it is unlikely that the pond would contain harmful levels of pesticides in water or sediment.

ATSDR released a Health Consultation in October 1996 to evaluate potential public health concerns associated with exposure to PCBs and DDT (and its metabolites) from consuming fish from contaminated portions of the Quantico Embayment of the Potomac River. ATSDR concluded that consumption of fish and shellfish from the Quantico Embayment does not pose a health concern for the general public. However, it was noted that specific sub-populations,

including any local subsistence fishers or persons living on base who consume locally obtained fish/shellfish should be informed not to exceed the recommended maximum consumption rates for the species of interest (ATSDR 1994).

ATSDR conducted a follow-up site visit of MCCDC Quantico from January 27-30, 2003. During this follow-up site visit ATSDR met with MCCDC Quantico representatives, collected updated information about current investigations and the remedial status of IRP sites on base, and discussed specific timelines for the release of ATSDR's PHA for MCCDC Quantico. ATSDR works closely with MCCDC Quantico officials, state and federal regulatory agencies, and the community to prepare a PHA document that reflects the most current information about the site and the concerns that are identified by community members.

4. Demographics

ATSDR examines demographic data (i.e., population information) to determine the number of people potentially exposed to environmental chemicals. This information is also used to determine the presence of sensitive populations, such as women of childbearing age (15 to 44 years old), children (6 and younger), and the elderly (65 and older). Demographic data also provide details on population mobility, which in turn help ATSDR evaluate how long residents might have been exposed to environmental chemicals.

MCCDC Quantico currently employs approximately 11,300 military and civilian personnel (consisting of approximately 9,500 military and 1,800 civilian persons. Military personnel can conduct tours of duty for a maximum of 3 years. However, military personnel can conduct multiple tours of duty and civilian personnel may work on Base for a number of years (Tetra Tech 2002). Approximately 3,674 Marines and their families live on base. There are four schools on base: three elementary schools with a total of 772 children, and one middle school with a total of 324 students. There is a child development center (CDC) on base that provides daycare services for as many as 290 children. The CDC provides care for children ranging from 6 months to 5 years of age (MCCDC 2002; Roberta Simpson, Assistant director of CDC, Personal Communication, July 16, 2003).

The town of Quantico has a population of approximately 560 people. There are 295 households out of which 19.7% have children under the age of 18 living with them, 21.4% are married couples living together, 11.2% have a female householder with no husband present, and 63.4% are non-families (US Census 2000).

5. Land Use and Natural Resources

Land use at MCCDC Quantico as well as in surrounding communities is primarily rural, with some residential areas and large portions of land used for recreational activities (e.g., fishing, hiking, hunting). Prince William Forest Park, a national park that covers approximately 17,000 acres, is located just northeast of the base (Tetra Tech 2003a). Approximately 80 percent of MCCDC Quantico is wooded, with substantial stands of both pine and hardwood species. These woodlands are used for training, recreation, timber, aesthetics, wildlife management, and watershed protection. Timber is produced and harvested in both areas (the Mainside and Guad Area) of the base and approximately 64 percent is under forest management (Tetra Tech 2003a; Tetra Tech 2002; Tetra Tech 2000b).

Approximately 4 miles of managed trout streams, 12 miles of tidal shoreline, and eight ponds and lakes are located within MCCDC Quantico. Fresh water fish include small mouth bass, large mouth bass, white bass, bluegill, red eye sunfish, pickerel, catfish, and rainbow trout.

Approximately 3,900 acres of wetlands exist within MCCDC Quantico. Of these, 525 acres are associated with Chopawamsic Creek and the Potomac River. These wetlands are tidally influenced and support both aquatic and semi-aquatic vegetation. The Potomac River near MCCDC Quantico, including the inlet of the river referred to as the Quantico Embayment, is a commercial and recreational fishing area. The Chopawamsic Creek area is classified as a nursery for commercial fish and sport fish. Deer, turkey, squirrel, rabbit, quail, grouse, woodcock dove, waterfowl, fox, beaver, muskrat, skunk, and raccoon are among the most common wildlife species at MCCDC Quantico. Otter, mink, and muskrats have also been reported in nearby water bodies (Hart Associates 1984; Radian 1992a; Tetra Tech 2000b).

Within the boundary of MCCDC Quantico are several small training camps: Camp Barrett (The Basic School), which is located along the southern boundary of the installation; Camp Upshur, which is located along the northern boundary; and Camp Goettge (abandoned), which is located along the western boundary. Also within the base boundary are several non-Marine Corps managed properties: the town of Quantico, located wholly within the installation along the northeastern boundary of the Base; Midway Island, located along the southeastern edge of the installation and owned by the Naval Research Laboratory; and the FBI Academy, located within the central portion of the installation (Tetra Tech 1999).

The source of drinking water at MCCDC Quantico and surrounding communities is surface water. West of Interstate Route 95, the Chopawamsic feeds the Breckenridge Reservoir. The reservoir serves as MCCDC Quantico's primary drinking water supply. Lunga Reservoir on Beaverdam Run is an alternate water supply for MCCDC Quantico. The Aquia Reservoir (Smith Lake), also fed by Beaverdam Run, is the drinking water supply to portions of Stafford County (Hart Associates 1994).

The Mainside Area Water Plant supplies drinking water to most of MCCDC Quantico. There are six storage tanks with a capacity between 2 and 3 million gallons each available for the Mainside Area drinking water system. The Mainside Water Treatment Plant is capable of treating 65-75 million gallons of water per month. The water is treated with liquid alum, fluoride, and is chlorinated prior to filtration. The water from the Breckenridge Reservoir supplies the entire base and the town of Quantico with the exception of Camp Upshur, Camp Barrett, the FBI Academy, and the Rifle Range (MCBQ 2002; Hart Associates 1984).

In the past, camp Upshur had its own water treatment plant and obtained its water from Cedar Run. The plant was only in operation from April to October and treated approximately 6 million gallons of water during the period of operation. A potable water treatment plant was located at Camp Barrett and obtained its water from Beaver Dam Run. Camp Barrett treated approximately 13-16 million gallons of water per month and distributed water to Camp Barrett, the FBI, and the Rifle Range.

Since March 2000, Camp Barrett has been supplied with water from the Smith Lake Water Treatment Plant in Stafford County. Camp Upshur has been using three water supply wells since 2000 when its former water treatment plant was closed and demolished. The drinking water for MCCDC Quantico has met all state and federal safe drinking water standards (MCBQ 2002; Hart Associates 1984).

The Potomac River is not used for drinking water or agricultural irrigation uses for at least five miles downstream and two miles upstream of the base. The river is used for both recreational and commercial fishing adjacent to the base. Other recreational uses include boating, and hunting along the shore (Radian 1992a). Both Aquia Creek and Smith Lake are used for recreational purposes, such as fishing, boating, and hunting. Groundwater is not currently used as a source of drinking water at MCCDC Quantico (Tetra Tech 2002).

6. Hydrogeology

MCCDC Quantico is primarily situated in the Piedmont and Coastal Plain Province. Portions of the drainage systems that lie in the Piedmont Province typically have streams that flow rapidly through steeply cut valleys where the soils are thin and bedrock materials are often found at or just below the stream bottom. As the streams enter the Coastal Plain Province, they generally become wider and slow down (Hart Associates 1994).

MCCDC Quantico has many sources of water with numerous drainage systems that generally flow towards the east-southeast in the direction of the Potomac River. The greatest potential for pollutant migration at MCCDC Quantico is via surface water. This is especially true west of Interstate 95 in the Piedmont geomorphic province. In the Piedmont province thin soils and shallow bedrock conditions contribute to-surface runoff. There is a low potential for migration through the ground water due to the presence of thin soils and shallow underlying bedrock, which tends to facilitate runoff of precipitation rather than percolation vertically through the soil layers (Hart Associates 1984).

Surface Water —

MCCDC Quantico is bounded on the east by over three miles of Potomac River shoreline. The Potomac River is divided into three estuarial zones, which include the Tidal Potomac River, the Potomac Transition Zone, and the Potomac Estuary. MCCDC Quantico is located adjacent to the Potomac Transition Zone between the Tidal Potomac River and the Potomac Estuary. The Potomac Transition Zone receives both fresh water from the Tidal Potomac River and saline water from the Potomac Estuary (Tetra Tech 2000b).

The Quantico Creek, Little Creek, Chopawamsic Creek, Tank Creek, and Aquia Creek watersheds drain the southeastern areas of MCCDC Quantico into the Potomac River. The Cedar Run, South Fork Quantico Creek, Beaverdam Run, and Cannon Creek watersheds drain the northwestern portions of MCCDC Quantico. The South Fork of Quantico Creek feeds the Quantico Creek watershed that flows outside the base into Prince William Forest Park (Tetra Tech 2002). The Chopawamsic Creek system drains the central and east sections of the facility and feeds the base water supply to Breckenridge Reservoir; the Aquia Creek system drains the southern portion of the facility and feeds the base water supply to Lunga Reservoir; and Little Creek and Tank Creek drain the northern and southern sections of Main side, respectively (Tetra Tech 2000b; Tetra Tech 2002).

A number of ponds and reservoirs are also present at MCCDC Quantico. The major ponds on base include Barrett Pond, Dalton Pond, R-6 Pond, and Upshur Pond. The reservoirs on base include Aquia Reservoir, Breckinridge Reservoir, Graves Reservoir, and Lunga Reservoir (Hart Associates 1984).

Groundwater —

Groundwater in the Piedmont Province is generally unconfined and nearly all groundwater in the bedrock is present in open fractures, joints, and seams. In contrast, groundwater in the Coastal Plain Province is present within both unconfined and confined aquifers, both within the soil overburden and within the underlying sedimentary formations. In this Coastal Plain province

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soils are relatively thick and underlain by more permeable materials. Groundwater flow in the Coastal Plain aquifer is most likely to the south and southeast toward Chopawamsic Creek and the Potomac River (ABB 1992). The differences in hydrogeology between the two provinces result in a greater likelihood of groundwater contaminants migrating through the Coastal Plain sections of MCCDC Quantico compared with those portions of the base that lie within the Piedmont Province. All potential sources of pollution at MCCDC Quantico are either in the Piedmont province or along the Chopawamsic Creek or Potomac River and, therefore, tend to migrate via surface waters (Hart Associates 1984).

As part of groundwater investigations at MCCDC Quantico, the depth to the apparent water table was measured inside six temporary monitoring wells in the study area. Groundwater was present at the Old Landfill at depths ranging from approximately one foot below ground surface (bgs) to nine feet bgs. Based on available topographic survey data and water table depth information, the water table slopes generally south towards Chopawamsic Creek (ABB 1992).

All of the groundwater supply wells in Prince William County are hydraulically upgradient of all of the MCCDC Quantico study areas and are at least 2 1/2 miles away (Radian 1992b). Nine inactive groundwater supply wells are reported to exist on base. However, site investigators only identified six of the nine wells. They are located at the airfield, Officer's Candidate School (OCS) training facility, the ammunition dump, Naval Hospital, Chamberline Village, and Midway Island. The location of the other three wells is unknown. In 1993, all of the identified wells were capped as recommended by the VDEQ. All wells are inactive or on standby status for potential emergencies and none of the wells have been utilized for potable water in over 20 years (Tetra Tech 2002; Hart Associates 1984).

In addition to those wells mentioned previously, MCCDC Quantico has recently activated three new water supply wells at Camp Upshur. MCCDC Quantico activated these additional wells between 1998 and 2000. These wells are located in the Atlantic Coastal Plain province and are screened at depths greater than 300 feet below the ground surface (Tetra Tech 2002).

7. Quality Assurance and Quality Control

In preparing this PHA, ATSDR reviewed and evaluated environmental data provided in various reports prepared by the DON, DON Contractors, and other parties. Documents prepared for the DON's environmental sites have DON, VDEQ, and USEPA oversight to verify that the data meets specific quality assurance and quality control measures for chain-of-custody procedures, laboratory procedures, and data reporting. These reports note any limitations to the sampling data. ATSDR's evaluation of the data included looking for inconsistencies and data gaps. The validity of analyses and conclusions drawn in this PHA are based on the reliability of the information referenced in reports related to MCCDC Quantico. ATSDR believes that the quality of environmental data available in documents relating to MCCDC Quantico is sufficient for public health decisions.

III. Environmental Contamination, Human Exposure Pathways, and Public Health Implications of Exposure

In this section, ATSDR evaluates whether community members have been (past), are (current), or will be (future) exposed to harmful levels of chemicals. Figure 4 describes the conservative exposure evaluation process used by ATSDR. ATSDR screens the concentrations of contaminants in environmental media (e.g., groundwater or soil) against health-based comparison values (CVs) (See text box below and Appendix C). Because CVs are not thresholds of toxicity, environmental levels that exceed CVs would not necessarily produce adverse health effects (Refer to Appendix D for a more detailed explanation of ATSDR's process of evaluating health effects). If a chemical is found in the environment at levels exceeding its corresponding CV, ATSDR estimates site-specific exposure and evaluates the likelihood of adverse health effects. *ATSDR emphasizes that a public health hazard exists only if exposure to a hazardous substance occurs at sufficient concentration, frequency and duration for harmful effects to occur.*

What is meant by exposure?

ATSDR's public health assessments are driven by evaluation of the potential for human exposure, or contact with environmental contaminants. Chemical substances released into the environment have the potential to cause adverse health effects. However, ***a release does not always result in human exposure.*** People can only be exposed to a chemical substance if they come in contact with it (e.g., if they breathe, eat, drink, or come into skin contact with the substance or environmental media containing the chemical).

If someone is exposed, will they get sick?

Exposure does not always result in harmful health effects. The type and severity of health effects a person can experience because of contact with a contaminant depend on the exposure concentration (how much), the frequency and/or duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and the multiplicity of exposure (combination of contaminants). Once exposure occurs, characteristics such as age, sex,

nutritional status, genetics, lifestyle, and health status of the exposed individual influence how the individual absorbs, distributes, metabolizes, and excretes the contaminant. Together, these factors and characteristics will determine how people might be impacted by any substances they come in contact with.

In almost any situation, there is considerable uncertainty about the true level of exposure to environmental contamination. To account for this uncertainty and to be protective of public health, ATSDR scientists typically use very health-protective exposure level estimates (e.g., worst case scenario) as the basis for determining whether adverse health effects are possible. These estimated exposure levels usually are much higher than the levels that people are really exposed to. If the exposure levels indicate that adverse health effects are possible, ATSDR performs a more detailed review of exposure, also consulting the toxicologic and epidemiologic literature for scientific information about the health effects from exposure to hazardous substances.

About ATSDR's Comparison Values (CVs)

CVs are not thresholds for adverse health effects. ATSDR CVs represent contaminant concentrations many times lower than levels at which no effects were observed in experimental animals or human epidemiologic studies. If contaminant concentrations are above CVs, ATSDR further analyzes exposure variables (for example, duration and frequency of exposure), the toxicology of the contaminant, other epidemiology studies, and the weight of evidence for health effects. Some of the CVs used by ATSDR scientists include:

EMEGs — environmental media evaluation guides
RMEGs — reference dose media evaluation guides,
CREGs — cancer risk evaluation guides, and
MCLs — EPA's maximum contaminant levels (MCLs).

EMEGs, RMEGs, and CREGs are non-enforceable, health-based CVs developed by ATSDR for screening environmental contamination for further evaluation. MCLs are enforceable drinking water regulations developed to protect public health.

You can find out more about the ATSDR evaluation process by consulting Appendix B, reading ATSDR's *Public Health Assessment Guidance Manual* at <http://www.atsdr.cdc.gov/HAC/HAGM/>, or contacting ATSDR at 1-888-42ATSDR.

How does ATSDR determine what exposure situations to evaluate?

ATSDR scientists evaluate site conditions to determine if people could have been, are, or could be exposed (i.e., exposed in a past scenario, a current scenario, or a future scenario) to site-

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related contaminants. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, sediment, water, air, or biota) has occurred, is occurring, or will occur through ingestion, dermal (skin) contact, or inhalation.

If exposure was, is, or could be possible, ATSDR scientists consider whether contamination is present at levels that might affect public health. ATSDR scientists select contaminants for further evaluation by comparing them against health-based comparison values (CVs). These are developed by ATSDR from available scientific literature related to exposure and health effects. Refer to Appendix C for a description of the CVs that are used in this document. CVs are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

Following the strategy outlined above, ATSDR examined whether human exposure to harmful levels of contaminants via these pathways existed in the past, exists now, or could potentially exist in the future. ATSDR summarizes its evaluation of these exposure pathways in Table 1 and describes it in more detail in the discussion that follows. To acquaint readers with terminology used in this report, a glossary is included in Appendix E.

What potential exposure situations were evaluated for MCCDC Quantico?

ATSDR reviewed the environmental data generated from initial environmental assessments and remedial investigations (RIs) of the sites at MCCDC Quantico to determine if there are any associated past, current, or future public health hazards. ATSDR also evaluated other environmental data such as drinking water monitoring data and sediment and fish tissue sampling data collected by the Virginia Department of Environmental Quality (VDEQ).

ATSDR identified three potential exposure situations associated with site-related contaminants at MCCDC Quantico for further evaluation:

1. Potential exposure to lead in surface soil of the Former Firing Range
2. Potential exposure to lead and asbestos in family housing.
3. Contamination in the Quantico Embayment and other surface water features abutting MCCDC Quantico from the Old Landfill (Site 4) and other MCCDC Quantico source areas

Table 1 provides a summary of the potential exposure situations evaluated in this PHA.



Table 1: Exposure Situation Summary Table –MCCDC QUANTICO					
Exposure Situation	Time Frame	Exposure	Public Health Hazard	Actions Taken or Recommended	Comments
1. Coming in Contact with Contaminated Soil at the Former Rifle Range (FRR)					
<ul style="list-style-type: none"> ▪ Adults and children who are able to access the FRR (Site 20) from on-site base housing (Argonne Hills) area. 	Past	No	<p>Former Rifle Range: Potential for past and current exposure to heavy metals (e.g., lead, copper, cadmium) in surface soil.</p> <p>Most of the surface soil at the site is moderately or heavily covered with vegetation and only occasional contact with contaminated soil is likely. Access to the site is restricted by fencing. Due to the low potential for exposure this situation is <i>does not pose a health hazard.</i></p>	<p>The actions taken at the FRR include:</p> <ul style="list-style-type: none"> ❑ In 1994, sediment control measures were implemented to reduce lead-contaminated sediments from impacting surface water in close proximity to the FRR. ❑ Fencing was installed and some signs posted around 1994 to restrict access to the range and alert people of potential lead hazards. ❑ In February 1995, MCCDC Quantico distributed a Fact Sheet regarding the potential for lead hazards at the Argonne Hills Housing Area. The fact sheet included questions and answers about the nature of the hazard and preventive measures being taken by MCCDC Quantico to reduce the hazard. ❑ Erosion control measures have been taken to help prevent lead-contaminated sediments and water from migrating off site. 	<p>Quantico installed a jogging trail (Butts Trail) at this site in 2001. As part of the FRR RI sampling in 2002, thirty samples were collected along the trail approximately 100 feet apart. According to site representatives, lead was not detected at levels of concern. The FRR fence is intact with appropriate signage along the fence line (Charles Grimm, MCCDC Quantico IR Section, Personal Correspondence, November 25 2003; Major Schilke, Deputy, Natural Resources and Environmental Affairs Branch, Personal Correspondence, December 9, 2003).</p> <p>During the site visit to MCCDC Quantico in January 2003, ATSDR identified portions of the Argonne Hills housing area fence that were not in tact. However, MCCDC Quantico representatives later explained that there was another fence surrounding the FRR that was in tact with signs posted warning of potential lead hazards.</p>
	Current	No			
	Future	No			



Table 1: Exposure Situation Summary Table - MCCDC QUANTICO (continued)					
Exposure Situation	Time Frame	Exposure	Public Health Hazard	Actions Taken or Recommended	Comments
2. Exposure to lead and asbestos in on-site base housing areas					
<ul style="list-style-type: none"> ▪ Adults and children living in on-base housing who come in contact with asbestos or lead in contaminated dust or soil. 	Past	Possible	<p><i>Past exposures to asbestos or lead in family housing were an indeterminate public health hazard. Since information is not currently available to evaluate the extent of past exposure, it is considered an indeterminate public health hazard.</i></p> <p><i>Current and future exposures to lead or asbestos pose no public health hazard because family housing has been replaced or renovated eliminating exposure hazards.</i></p>	<p>The actions taken include:</p> <ul style="list-style-type: none"> ❑ In 1994 the Navy performed a comprehensive assessment of family housing to determine the presence of asbestos and lead in family housing. ❑ The MCCDC Quantico housing office distributes information about lead hazards and provides educational materials about how to reduce potential exposures to lead. ❑ Demolition and renovation of older base housing under a public-private venture (PPV) initiative. 	<p>Most of the older housing areas are scheduled to be abandoned completely or replaced by new housing units in the same location. MCCDC Quantico will renovate or demolish on-base housing areas built prior to 1978.</p>
	Current	No			
	Future	No			

Table 1: Exposure Situation Summary Table - MCCDC QUANTICO (continued)					
Exposure Situation	Time Frame	Exposure	Public Health Hazard?	Actions Taken or Recommended	Comments
3. Eating Fish and other Foods from the Quantico Embayment and Portions of the Potomac River in Close Proximity to QMCB					
<ul style="list-style-type: none"> People who fish, trap crabs, or harvest other foods from the contaminated areas of the Quantico Embayment area and from portions of the Potomac River that have been impacted by site-related contaminants. 	Past	Yes	<p>Quantico Embayment and other surface water bodies near MCCDC Quantico (e.g., the Chopawamsic Creek): Potential exists for past, current, and future exposure to PCB and pesticides from consuming fish and other edible animal species caught in surface water bodies near MCCDC Quantico.</p> <p><i>Past, current and future consumption of fish and shellfish from the embayment does not pose a health hazard for the occasional recreational fisher following the existing consumption advisory.</i></p> <p>Fish consumption patterns in groups that frequently consume fish from the Quantico Embayment and other contaminated waters near MCCDC Quantico has not been well documented. The current fish consumption advisory is limited to one fish species (channel catfish) greater than 18 inches in length.</p>	<p>MCCDC Quantico has taken a number of actions to reduce or eliminate the source of contamination from further impacting the Quantico Embayment and other water bodies in close proximity to the Old Landfill (Site 4).</p> <p>Actions taken include:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Installation of a permeable soil barrier covering approximately 23 acres. <input type="checkbox"/> Approximately 3,000 feet of chain-link fencing was installed around the perimeter to control access to the site. <input type="checkbox"/> Wetland areas were established replacing wetlands that were destroyed or impacted during the installation of the permeable soil barrier. <input type="checkbox"/> Four on-site buildings were demolished and the landfill surface was cleared. <input type="checkbox"/> Nearly 5,000 tons of soil and sediment containing PCBs greater than 10 ppm was excavated and disposed off site. <p>Approximately 3,500 cubic yards of</p>	<p>In addition to soil, groundwater, surface water and sediment sampling conducted on site by MCCDC Quantico, the U.S. Fish and Wildlife Service conducted two rounds of fish and invertebrate sampling within the Quantico Embayment and three reference locations, one in 1993 and a second round in 1995.</p> <p>Bottom feeding species such as carp and channel catfish contained the highest concentrations of PCBs and pesticides sampled from Quantico Embayment and the other reference areas.</p> <p>Average PCB concentrations detected in carp samples collected from the Quantico Embayment were approximately 5 times higher than average PCB concentrations from carp samples collected from the Powells (i.e., one of the reference locations) area.</p> <p>Pesticide concentrations (e.g., total DDT, dieldrin and chlordane) were considerably higher in samples collected from the Quantico Embayment compared to those collected from the three other reference locations.</p>
	Current	Yes			
	Future	Yes			



		<p><i>This may not adequately protect all people, especially anglers or other populations who frequently consume large amounts of smaller catfish other fish species from the Quantico Embayment area. Until additional sampling data is collected for other common edible species and more is known about the fishing consumption patterns of certain sub-populations in the area, ATSDR considers consumption of fish by high-end consumers to be an indeterminate public health hazard.</i></p>	<p>waste, debris, and sediment were excavated from the Quantico Embayment area.</p>	
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a. Potential exposure to lead in surface soil of the Former Firing Range

Issue

Are or were children who come in contact (or have come in contact in the past) with surface soil at the FRR likely exposed to harmful levels of lead?

Characterization of Potential Exposure Pathway

The FRR comprises approximately 51 acres and is the location of six former firing range areas, consisting of pistol, rifle, and skeet ranges, used from the mid-1930s through the mid-1960s. Natural hillsides that were present at the site were used as impact berms for shooting activities. According to past record reviews, a large area surrounding Lejeune Hall is believed to be the original rifle range. The hillside west of Lejeune Hall has been used as an impact berm during long-range rifle training. Impact berms located north of Russell Road are still in place (Halliburton 1993; Tetra Tech 1999).

The FRR is bounded to the east and south by industrialized portions of the Base. Two roads (Catlin Avenue and Russell Road) border the southern side of the site. Chopawamsic Creek is located on the southern side of Russell Road, and Lejeune Hall is located on the southern side of Catlin Avenue. The area surrounding the ranges, as well as the hillside west of Lejeune Hall where the impact berms are located, is forested. The actual site is heavily vegetated and is undeveloped (Tetra tech 2003b).

The northern portion of the FRR borders McCard Road and Argonne Hills, an on-base residential area. According to MCCDC Quantico representatives, as of June 2003, there were 121 families living at the Argonne Hills housing area. The housing units in this area are scheduled to be demolished or redeveloped depending on the condition and housing type (Lieutenant Luke Greene, Director of Housing MCCDC Quantico, Personal Communication, June 30, 2003). During ATSDR's site visit in January 2003 some of the units were vacant,

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however, there was evidence of people living in a few of the homes (e.g., toys in the yard, grills, and lawn furniture).

Two fences restrict access to the FRR near the Argonne Hills housing area. Portions of the outer fence, closest to the housing area, are damaged and signs warning about potential lead hazards are limited. However, a newer fence surrounding the FRR is in place and is completely in tact with signs posted along the fence that warn of potential lead hazards (Major R. Schilke, Deputy, Natural Resources and Environmental Affairs Branch, MCCDC Quantico, Personal Communications, December 9, 2003).

Nature and Extent of Contamination

The environmental media at the FRR and surrounding areas were sampled during various investigations to determine the nature and extent of contamination. These investigations were conducted between 1988 (during the Site Inspection sampling effort) and 2002 (Data gap investigation). The media investigated include soil, groundwater, sediment, and surface water (Halliburton 1993; Tetra Tech 1999). During the course of the field investigations samples were collected and analyzed primarily for metals and some samples were selected for VOCs, SVOCs, and PAHs.

High concentrations of lead are present in berms and downrange locations from projectiles fired at each of the known ranges. High concentrations of lead have also been detected along the firing line. This contamination may be attributed to the spray and fume deposition of projectile material that is generated after exiting the firearm and may also be from metallic residue from spent cartridges (Tetra Tech 1999). Table 2 shows that the highest lead concentration in surface soil (39,600 ppm) was detected at the skeet range (Range D), located in the northern portion of Site 20. Lead was detected in surface soil well above EPA's recommended clean-up level for residential soil in each of the ranges except for Range E. PAHs have also been detected at concentrations exceeding 10 ppb in surface soil samples.

Groundwater samples were collected from nine monitoring wells that were installed at the FRR. The maximum lead concentrations detected in groundwater samples was 5.7 ppb. Surface water

and sediment samples were collected from drainage areas within the FRR tributary to Chopawamsic Creek to characterize the potential for off-site migration of lead. Dissolved lead concentrations in surface water ranged from 2.9 to 13.4 ppb (total lead concentrations ranged from 7.3 to 3,600 ppb) (Tetra Tech 1999). Lead concentrations detected in sediment samples associated with the FRR ranged from 11.9 ppm to 3,360 ppm.

Table 2. Range of Lead Concentrations in Soil Detected at the Specified Range Areas at the FRR (Site 20)			
Location	Range of Lead Concentration (ppm)¹	Sample with the Maximum Concentration	Comments
Range A – Pistol Range	18.2 — 6,965	SO15	The highest concentrations were detected at the downrange portion of Range A. The maximum value is the average of a field duplicate pair whose individual analytical results were 5,750 and 8,180 ppm.
Range B – Rifle Range	7.4 — 2,520	SO32	The sample with maximum concentration was collected from the southern half of the downrange berm.
Range C – Pistol Range	63.7 — 23,300	SO50	No Comments
Range D – Skeet Range	71 — 39,600	SO71	Three samples (SO71, SO72, and SO76) contained lead in excess of 32,000 ppm
Range E – Pistol Range	24.3 — 59	SO27	No Comments
Range F – Skeet Range	135 — 12,600	SO84	No Comments
Source: Halliburton 1993; Tetra Tech 1999			
¹ Surface Soil (0 – 6 inches) Notes: 1. Background soil samples were collected from two nearby off-site locations (near base housing) and the average lead concentration was 15 ppm. 2. The data presented in this table reflect the sampling results from the Site Inspection Report (1993) and the Remedial Investigation for Site 20 (1999). ATSDR reviewed the limited data from earlier sampling efforts and the concentrations of lead identified in earlier sampling did not exceed the maximum concentrations that were detected in later sampling rounds. 3. While there is no national soil standard (or screening value) for lead, EPA's Office of Solid Waste recommends that soil lead levels less than 400 parts per million (ppm) are considered safe for residential use (EPA 1997).			

Evaluation of Potential Public Health Hazards

Surface and subsurface soil at all of the ranges within Site 20 are contaminated with lead. However, a fence currently separates the FRR from the on-base housing area (Argonne Hills). **ATSDR therefore concludes that past, current, and future exposures to lead in surface soil do not pose a public health hazard for children living on base.** Our evaluation indicates that

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although the FRR may have been accessible to children in the past, the portions of the site where elevated lead levels have been found (e.g., bermed areas) are heavily vegetated and not likely to be an efficient pathway of exposure. Contact with surface soil is impeded by vegetative growth, and it is unlikely that occasional contact with surface soil at the FRR resulted in harm to children or other trespassers.

Other potential pathways of exposure evaluated at the FRR such as groundwater, surface water, and sediments do not pose a public health hazard to children or other trespassers. Groundwater is not used beneath the FRR and groundwater monitoring did not identify levels of lead greater than 10 ppb. Some elevated lead in sediments (i.e., greater than 400 ppm) and surface water (i.e., greater than 10 ppb) were detected at the FRR. Most of these elevated samples were collected near contaminated berms at the individual ranges that comprise FRR. Access to the range areas is restricted to authorized personnel and occasional exposure to contaminated sediments or surface water would not likely be sufficient to cause harm.

ATSDR identified potential exposure pathways associated with the FRR during the agency's initial site visit in October 1994. Signs warning of possible lead hazards from lead dust and lead in soil remaining from the impact berms at the FRR were posted at various locations throughout the site at the time of ATSDR's initial site visit. In the follow-up Site Summary report, ATSDR recommended posting additional signs warning residents about the hazard contamination at the FRR along the fence line facing the Argonne Hills housing area north of the site and distributing educational materials to residents about the hazards of allowing children to play on the site. In February 1995, the Natural Resources and Environmental Affairs Branch at MCCDC Quantico developed a fact sheet titled "Argonne Hills Housing Area Lead Hazard." This fact sheet warned residents of the Argonne Hills housing area about the potential for exposure to lead from the FRR that borders the housing area (MCCDC 1995). This fact sheet was distributed to residents living near the FRR.

ATSDR evaluated certain conditions at the FRR that could result in a completed exposure pathway. During ATSDR's follow-up site visit in January 2003, a tour of the Argonne Hills base-housing area north of the FRR revealed that the fence that was believed to separate the

housing area and the FRR was damaged presumably allowing access to the range. However, ATSDR was later informed that a newer fence was installed closer to the FRR and is completely in tact with signs posted along the fence warning of lead hazards.

According to site investigation reports, the highest concentrations of lead were detected in surface soil samples at the former skeet range (Range D), which is the closest range (approximately 300 feet) to the Argonne Hills housing area. The maximum lead concentrations in surface soil were detected approximately 600 feet southwest of the Argonne Hills housing area. However, as long as the newer fence remains in tact it is very unlikely that children will come in contact with lead-contaminated soil. Additionally, a soil removal action will commence in 2004, further eliminating potential sources of lead-contaminated soil at the FRR. It is possible that children may have been able to access the FRR prior to the installation of the newer fence. However, it is unlikely that children were exposed to lead-contaminated soils in the past with enough frequency to be harmful because the thick vegetation would prevent direct contact with contaminated soil. ***Therefore, ATSDR considers past, current, and future exposures to lead in surface soil at the FRR to pose no apparent public health hazard.***

b. Potential exposure to lead and asbestos in family housing

Issue

Is there currently or was there in the past an exposure hazard to lead and asbestos in on-base housing?

Characterization of Potential Exposure Pathway

Most of MCCDC Quantico's former on-base housing stock was built prior to 1978 and contained lead-based paint and building materials containing asbestos (ACM). The ACM in some areas, particularly pipe insulation, was in a condition of deterioration, indicating the potential for

exposure if the material was significantly disturbed. Although the condition of the paint in older base housing units varied considerably, many of the older units contain paint surfaces that are deteriorating (e.g., loose and peeling paint) and likely pose hazards to children who are living or who may have lived in the units in the past. According to base representatives, approximately 640 children under the age of six reside in on-base family housing units at MCCDC Quantico.

MCCDC Quantico is in the process of updating the on-base housing areas. A public-private venture (PPV) initiative at MCCDC Quantico will result in an estimated 1,136 new housing units with construction that began in September 2003. Once the new housing is completed, a large portion of the older housing stock at MCCDC Quantico will be demolished or abandoned.

Nature and Extent of Contamination

In 1994, the MCCDC Quantico Public Works Center conducted an assessment of family housing areas at MCCDC Quantico for lead and asbestos containing materials (ACM). The assessment identified asbestos containing material (ACM) including tiled ceilings, flooring

containing asphalt/vinyl tiles, insulation, roofing, and walls. In 7 of the 18 housing areas, asbestos containing material (ACM) was identified in a condition that may pose an inhalation

What Should You Know About Lead in Your Home?

Until the discovery of its serious health effects, particularly in children, lead was used in gasoline, pipes, paint and other common products. In 1978, the Consumer Product Safety Commission banned the manufacture and use of lead-based paint in residential housing. The following information about how people may be exposed to lead is provided below:

- Children are usually poisoned by exposure to lead in peeling paint, dust and soil.
- Children swallow the lead that gets on their hands and toys in normal mouthing behavior.
- Lead paint was used in most houses and apartments built prior to the 1950s and in some until the late 1970s.
- Deteriorated or improperly removed lead paint contaminates dust and soil.
- Lead used in gasoline until the 1980s still contaminates soil, which children play in and which gets tracked and blown into the house.
- Although drinking water is generally not a major source of lead poisoning, there are some public water systems that have detected elevated levels of lead sampled at the tap. Lead detected in drinking water is usually due to lead in the pipes.
- Other lead hazards include lead dust brought home on work clothes and lead in hobby and craft materials.

Source: EHW 2001

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hazard if disturbed. The areas of deteriorating ACM were in locations generally inaccessible or in areas rarely frequented by building occupants, limiting the potential for exposure. During the assessment, no air or dust sampling was performed to detect asbestos. The Navy determined that as a precaution, the recommended short-term action was to remove and dispose of any asbestos containing materials in the housing areas (US Navy 1997).

The evaluation of lead included inspections of family housing units and other areas frequented by children on base (e.g., playgrounds, day care facility, clinics, etc). The evaluation included the testing of paint, dust, and soil for lead in a representative sample of housing units on base (US Navy 1997a).

Table 3 shows that the highest lead level detected in soil during the evaluation of lead in family housing was 24,705 parts per million (ppm) at the 600 Block apartments, which were constructed between 1920 and 1925. Thirteen of the 19 housing areas contained at least one sample that exceeded EPA's action level of 400 ppm for lead in soil. The highest lead level detected in dust during the evaluation of lead in family housing was 30,971 ppm in a sample collected from a windowsill at the 1200 Block Naval Clinic. Five of the 19 housing (or dwelling) areas contained at least one sample that exceeded EPA's guidelines for lead in dust collected from floors (100 ug/ft²), windowsills (500 ug/ft²), or window wells (800 ug/ft²) (Table 3).

In addition to environmental testing, MCCDC Quantico conducts routine blood lead screening as part of the child wellness program. The Pediatric Lead Poisoning Prevention Screening Program was established in 1994. Blood lead test results are sent back to the pediatric nurse on a weekly basis and parents are subsequently notified of their child's test result. According to MCCDC Quantico representatives, there have been no cases of elevated blood lead (i.e., blood lead levels above 10 ug/dl) identified in children living on base (Lieutenant Daron Patton, MCCDC Quantico, Personal Communications, March 17, 2003; Major R. Schilke, Deputy, Natural Resources and Environmental Affairs Branch, MCCDC Quantico, Personal Communications, December 9, 2003).

Table 3. Lead Concentrations Detected in Soil and Dust at MCCDC Quantico On-Base Housing Areas				
Location	Maximum Soil Concentration (PPM)¹	Maximum Dust Concentration (ug/ft²)²	Number of Units, Age of Housing Area, and Anticipated Future Plans	
Lettered Apartments A-E	816 (12)	32 (32)	Contains 30 units constructed in 1929. Expected to be rehabilitated in 2006.	
Lettered Apartments F- T	0 (19)	0 (25)	Contains 84 units constructed in 1936. Expected to be rehabilitated in 2006.	
1100 Block	910 (20)	40 (80)	Contains 9 units constructed in 1940. Expected to be redeveloped in 2007.	
2207 Apartments	1,735 (13)	159 (38)	Contains 11 units constructed in 1944. Expected to be redeveloped in 2007.	
Chamberlain Village	2,436 (19)	47 F (20)	Contains 49 units constructed in 1941. Expected to be demolished in 2007.	
Argonne Hills? Lustrons (800 and 2700 Block)	78 (17)	56 WS (32)	Contains 60 units constructed in 1948. Future status of housing area is undetermined.	
800 Block Singles and Duplexes	1,595 (16)	38 WS (40)	Contains 20 units constructed in 1949. Expected to be redeveloped in 2006.	
2700 Block Singles and Duplexes	2,386 (19)	126 F (40)	Contains 39 units constructed in 1948. Expected to be demolished in 2006.	
2000 Block Apartments	1,851 (24)	113 WS (47)	Contains 96 units constructed in 1939. Expected to be rehabilitated in 2005.	
Lyman Park	22 (7)	63 F (157)	Contains 448 units constructed in 1962. Expected to be redeveloped from 2004 to 2007.	
Thomason Park (2700 Block)	537 (72)	64 WS (144)	Contains 406 units constructed in 1952. Expected to be redeveloped 2003/2004.	
Split Levels	213 (38)	69 WS (80)	Contains 214 units constructed in 1957. Future status is unknown.	
GOQ/SOQ/FGR Housing	8,272 (198)	25,200 WW (357)	Contains 66 units constructed in 1920. Expected to be redeveloped in 2006/2007.	
Quarters 21 and 500 Block	363 (19)	107 F (40)	Contains 5 units constructed in 1918. Expected to be redeveloped in 2007.	
600 Block	24,705 (12)	487 F (23)	Contains 3 units constructed between 1920 and 1925. Expected to be redeveloped in 2007.	
1200 Block – Naval Clinic	7,993 (24)	30,971 WS (38)	Contains 11 units constructed in 1918. Expected to be demolished in 2007.	
2250,2251, and 2252	7,174 (12)	855 WS (24)	Contains 3 units constructed in 1942. Expected to be demolished as soon as the units become vacant.	
MCCDC Quantico Playgrounds	394 (58)	NA	NA	
700 Block	24,022 (15)	497 WS (39)	Contains 6 units constructed between 1920 and 1925. Expected to be redeveloped in 2007	

¹ PPM = Parts per million
² ug/ft² = Micrograms per square foot

Notes:
 Numbers in parentheses represent the number of samples collected;
 Values in bold exceed the EPA/HUD guidelines for that medium
 F = Floor; WS = Window Sill; WW = Window Well; NA = Not Applicable
 Action level for lead in soil = 400 ppm (HUD/EPA Guidelines)
 Action level for lead in dust:
 100 micrograms per square foot (floors).
 500 micrograms per square foot (window sill).
 800 micrograms per square foot (window well).

Evaluation of Potential Public Health Hazards

Most of MCCDC Quantico's current on-base housing stock was built prior to 1978 and contained lead-based paint and building materials containing asbestos. It is possible that adults and children living in old base housing were exposed to asbestos and lead. Exposure would depend on many factors, including: 1) how long a person lived in a particular housing unit; 2) the condition of the paint and ACM at the time they were living there; 3) specific activities that occurred in the housing unit that may have disturbed the ACM or resulted in contact with contaminated dust; and 4) other factors, such as the frequency of house cleaning that eliminated dust in the home.

The degree of potential exposure to asbestos was likely minimal. This was due to several factors, including areas of deteriorating ACM in locations that would be infrequently visited or generally inaccessible to building occupants (e.g. attics, areas behind furnace and water heaters, etc.). Furthermore, harmful exposures require consistent chronic exposure to high levels of asbestos dust, conditions that were unlikely met in base housing. However, to ATSDR's knowledge, no air monitoring was conducted as part of the initial 1994 survey, therefore we are unable to determine if asbestos exposure occurred, to what extent, and whether it was actually hazardous.

The potential for exposure to lead in deteriorating paint was much greater due to the widespread use of lead-based paint in living areas. However, lead screening in children is routinely conducted at MCCDC Quantico and there have been no reported cases of lead poisoning (i.e., blood lead levels above 10 ug/dl) identified in children living on base. The MCCDC Quantico housing office routinely distributes information about lead hazards and provides educational materials about how to reduce potential exposures to lead in older base housing.

As part of the PPV for new housing at MCCDC Quantico, the old housing will be replaced with new or renovated housing. According to MCCDC Quantico representatives, the PPV construction began in September 2003 and scheduled to be completed in 2008. This will greatly reduce any potential asbestos or lead hazards in the future for occupants living in on-base housing.

ATSDR concludes that past exposures to lead was possible. Due to the lack of sampling data it is unknown whether exposure to asbestos occurred. Since information is not currently available to evaluate past exposure, it is considered an indeterminate public health hazard. Current and future exposures to asbestos or lead in on-base housing do not pose a public health hazard.

c. Contamination in the Quantico Embayment and other surface water features abutting MCCDC Quantico from the Old Landfill (Site 4) and other MCCDC Quantico source areas

Characterization of Issue

Are the fish, seafood, or other wildlife harvested from potentially contaminated portions of the Quantico Embayment or other contaminated water bodies safe to eat?

Characterization of Potential Exposure Pathway

Portions of the Potomac River and its tributaries are popular fishing grounds and are used for harvesting other seafood (e.g., crab and eel) and hunting wildlife (e.g., duck). An inlet of the Potomac River referred to as the Quantico Embayment is located adjacent to the Old Landfill (Site 4) on MCCDC Quantico property. The water in the Quantico Embayment is typically 1-6 feet deep. There are several outfalls and storm water drains along the Quantico Embayment shoreline, including National Pollutant Discharge Elimination System (NPDES) permitted and non-permitted outfalls (Battelle 2002).

In general, there appears to be a regional PCB contamination problem with multiple sources of pollutants along the Potomac River. In addition to these regional sources, there is also a local contribution to PCB contamination in the embayment area from MCCDC Quantico. The largest source of PCB contamination identified at MCCDC Quantico is the Old Landfill (Site 4).

What is the National Permit Discharge Elimination System (NPDES)?

As authorized by the Clean Water Act, NPDES permits regulate wastewater discharges to lakes, streams, wetlands and other surface waters. NPDES permits control water pollution by regulating point sources that discharge pollutants into waters of the United States.

Point sources include pipes or man-made ditches that release effluent into surface waters. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

Source: USEPA 2002

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The Old Landfill is a 24-acre site located on the banks of the Potomac River in the Mainside Area of MCCDC Quantico (Figure 5). Site 4 is bound to the north and west by on-base industrialized areas (e.g., base sewage treatment plant to the north and railroad tracks and steam generation plant to the west). The southern edge of the site is partially surrounded by wetlands and barracks used by airfield personnel (US Navy 2003; Radian 1986; Radian 1987). The Old Landfill consists entirely of artificial fill. Originally, the shoreline was adjacent to the railroad tracks, but as a result of the landfill operations the shoreline was extended between 600 and 1,200 feet to the east (USFW 1997). The Quantico Embayment borders the Old Landfill and has been impacted by site-related contaminants migrating from surface water runoff and sediments.

Landfill operations at Site 4 began in the early 1920s and continued until 1971, when another landfill opened at the base. During its period of operation, the landfill received waste and debris materials associated with all base activities, including the hospital and airfield (US Navy 2003; Radian 1986; Radian 1987). In addition to the landfill, MCCDC Quantico also operated a scrap yard in the area through the 1980s. Fluids containing PCBs were typically drained from electrical transformers directly onto the ground or spread throughout the site to control dust. The site is currently an open grass-covered field and landfill waste is contained beneath a soil barrier layer. A chain-link fence has been installed around the perimeter of the site, except along the embayment portion of the river (US Navy 2003).

In 1992, VDEQ conducted fish and shellfish sampling in the Potomac River adjacent to the Old Landfill. The maximum PCB concentration reported from fish collected in April 1992 was 1.9 parts per million (ppm) wet weight in a whole body sample of sunfish. The maximum total DDT concentration (1.9 ppm) was also found in this sample (USFW 2000). As a result of these biota studies and water and sediment sampling data, VDEQ issued a Notice of Violation to MCCDC Quantico in the spring of 1993, concluding that the landfill was a source of contamination (e.g., PCB, pesticide, petroleum hydrocarbon, and metals) resulting in discharges to the Potomac River. VDEQ stated that further data were needed for an evaluation of human health risks from the consumption of fish and crabs from the Quantico Embayment (USFW 1995; USFW 2000; VDEQ 1993).

Nature and Extent of Contamination

Groundwater: Groundwater samples were collected from twenty-one monitoring wells (7 installed in 1986; 2 installed in 1988; 3 installed in 1991; and 9 installed in 1993/1994) during environmental investigations associated with the Old landfill (Site 4). Some VOCs and SVOCs were detected in groundwater samples collected at the landfill (Table 4) (US Navy 2003). Aroclor 1260 (19.8 ppb) and 4,4'-DDD (26 ppb) were also detected in some groundwater samples. However, the organic compounds were not detected with a high frequency in groundwater. Even 4,4'-DDD, which was detected most frequently among organic compounds, was only detected in about one-third of the samples analyzed. Twelve inorganic compounds (i.e., metals) were detected in groundwater samples including lead (10,800 ppm) and arsenic (207 ppm).

Soil and Sediment Sampling: Lead was the most frequently detected soil contaminant reported at the Old Landfill and was detected at a maximum concentration of 9,910 ppm (Table 5). PCBs were detected at very low concentrations in soil and sediment. Some common pesticides were also detected in soil (dieldrin – 1.7 ppm) and sediment (4,4'-DDD – 13.3 ppm). Pesticides have been used at various locations (e.g., golf course, pesticide control areas) over a long period of time at MCCDC Quantico and were periodically disposed of at the Old Landfill. The source of the pesticides may have also been the Pesticide Shop (Site 32). The shop burned down in the mid-1980s and may have contaminated portions of the embayment area (Major R. Schilke, Deputy, Natural Resources and Environmental Affairs Branch, MCCDC Quantico, Personal Communications, December 9, 2003).

Fish, and Shellfish Sampling: The U.S. Fish and Wildlife Service conducted Fish and shellfish sampling in 1993 (blue crab, eel, perch, sunfish, and carp) and 1995 (carp [whole body] and catfish [fillets]) from within the Quantico Embayment and also at several reference locations (i.e., the mouth of Powells Creek, Quantico Creek, and Chopawamsic Creek. Five crab, 10 catfish, 10 eel, 10 perch, 10 sunfish, and 18 carp were collected from the Quantico Embayment and analyzed on a wet weight basis for organochlorine pesticides, PCBs, and metals (with the exception of catfish which were not analyzed for metals). Reference tissue samples of 6 crab, 10

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catfish, 3 eel, 10 perch, 10 sunfish, and 8 carp were collected from the mouth of Powells Creek, 10 catfish and 2 carp from Quantico Creek, and 8 carp from Chopawamsic Creek (USFW 1995; USFW 1997; Tetra Tech 2000a). The maximum concentrations detected in the different tissue samples collected from the Quantico Embayment are presented in Table 6.

The highest levels of PCBs and pesticide residues were detected in the carp samples collected from the Quantico Embayment. Aroclor 1260 was detected in a carp sample at 3.5 ppm. This concentration is well above ATSDR's health-based screening value of 1 ppm for PCB in raw fish fillet for those people who consume an average of 1 meal per month. (Refer to Appendix F for an explanation of the assumptions used in developing this guideline). It exceeds the FDA's tolerance level of 2 ppm for PCBs in fish and shellfish tissue, developed as a guideline for commercial fish consumption (see Appendix A for a description of FDA's tolerance levels). The pesticide metabolite 4,4'-DDD was also detected in a carp sample at 9.7 ppm, which is above FDA's action level of 5 ppm for DDT residues in commercial fish and shell fish (USFW 1995; USFW 1997; Tetra Tech 2000a).

Concentrations of PCBs in fish samples collected from three reference locations (Chopawamsic Creek, Powells Creek, and Quantico Creek) were similar to the PCB concentrations detected in samples collected from the Quantico Embayment. However, the maximum PCB concentration detected in carp (3.5 ppm) from Quantico Embayment was higher than the maximum concentration detected in carp (1.9 ppm) from Powells Creek, 4.6 miles upriver (Tetra Tech 2000a). The average PCB concentration (1.5 ppm) in carp samples in the Embayment was more than four times higher than the average PCB concentration (0.35 ppm) in carp samples collected from Powells Creek. Pesticide concentrations in carp sampled from the Quantico Embayment were higher than those sampled from the reference locations. Most notable were the concentrations of total DDT (i.e., includes all metabolites) detected in carp from the Quantico Embayment (maximum = 12.9 ppm) compared with those carp samples collected from the reference locations (maximum = 1 ppm) (Tetra Tech 2000a). The mean total DDT concentration (0.70 ppm) in carp samples collected from the Quantico Embayment was one order of magnitude greater (i.e., 10 times greater) than the mean total DDT concentration (0.07 ppm) in carp samples collected at Powells Creek.

Table 4. Contaminants Detected in Groundwater at the Old Landfill (Site 4)					
Chemical	Maximum Concentration¹	Frequency of Detection²	Investigation³	Comparison Value (CV)⁴	Source
<i>Volatile Organics (VOCs)</i>					
Chlorobenzene	280	23/84	FFS (1994)	100	MCL
Methylene Chloride	9	5/75	PRI (1992)	5	MCL
Vinyl Chloride	16	7/75	PRI (1992)	2	MCL
<i>Semivolatile Organics (SVOCs)</i>					
Benzo(a)pyrene	12	3/83	FFS (1994)	0.2	MCL
Bis(2-ethylhexyl)phthalate	59	8/83	FFS (1994)	6	MCL
Hexachlorobenzene	13	1/83	FFS (1994)	1	MCL
<i>Pesticides and PCBs</i>					
Aroclor 1242	4.8	1/88	PRI (1992)	0.5	MCL
Aroclor 1260	19.8	9/85	PRI (1992)	0.5	MCL
4,4'-DDD	26	31/88	PRI (1992)	0.1	CREG
4,4'-DDE	3	24/88	PRI (1992)	0.1	CREG
<i>Inorganics (Metals)</i>					
Antimony	299	36/84	PRI (1992)	6	MCL
Arsenic	207	61/85	PRI (1992)	50	MCL
Barium	9,220	85/85	PRI (1992)	2,000	MCL
Beryllium	93.9	27/85	PRI (1992)	4	MCL
Cadmium	38.2	18/85	PRI (1992)	5	MCL
Chromium	450	42/85	PRI (1992)	100	MCL
Copper	1,810	52/85	PRI (1992)	1,000	EMEG (Adult)
Lead	10,800	61/85	PRI (1992)	15	EPAs Action Level
Manganese	3,040	85/85	FFS (1994)	2,000	RMEG (adult)
Mercury	4	22/85	PRI (1992)	2	MCL
Thallium	18.4	8/84	PRI (1992)	2	MCL
Zinc	11,400	66/85	PRI (1992)	10,000	RMEG (adult)
1. Concentrations are in parts per billion (ppb) 2. Frequency of Detection numbers include the combined sum of three investigations: 1) Preliminary RI; 2) Focused Feasibility Study (FFS); and 3) Post Remedial Action Study 3. The investigation listed pertains to the maximum concentration detected: FFS = Focused Feasibility Study; PRI = Preliminary Remedial Investigation 4 Concentrations are in ppb CREG = ATSDR's Cancer Risk Evaluation Guide; MCL = EPAs Maximum Contaminant Level					

Table 5. Contaminants Detected in Surface Soil and Sediment at the Old Landfill (Site 4)		
Chemical	Concentration (Range of Detected Values) (ppm)	Frequency of Detection
Surface Soil (0-1 foot)		
Benzo(a)pyrene	0.05 — 11	39/97
Dibenzo(a,h)anthracene	0.04 — 1.1	12/97
PCBs	ND — 170	10/11
Dieldrin	0.005 — 1.7	16/116
Antimony	1.4 — 524	34/125
Arsenic	0.5 — 52	117/127
Lead	1.7 — 9,910	127/127
Sediment		
Benzo(a)pyrene	0.009 — 0.32 (ERA)	32/34
4,4' DDD	0.001 — 13.3 (QEPIRA)	63/68
Aroclor 1260	0.02 — 2.3 (ERA)	59/68
Arsenic	0.8 — 8.4	33/34
Source: USFW 1999 (Ecological Risk Assessment [ERA]) ; Battelle.2003.Quantico Embayment Post-Interim Removal Action (QEPIRA); Radian 1986 (NACIP Confirmation Study)		

Table 6. Contaminants Detected in Fish and Other Biota Near the Old Landfill (Site 4)^{1,2}		
Fish Species	Chemical	Concentration (Range of Detected Values) (ppm)
Channel Catfish	PCBs (Aroclor 1260)	0.5 — 1.0
	PCBs (Aroclor 1254)	0.6 — 1.5
	4,4'-DDE	0.1 — 0.4
	Chlordane	0.05 — 0.2
Blue Crabs	PCBs (Aroclor 1260)	0.08
	4,4'-DDD	0.003 — 0.04
Eels	PCBs (Aroclor 1260)	0.3 — 1.5
	4,4'-DDD	0.008 — 1.2
	Dieldrin	0.002 — 0.2
Yellow Perch	PCBs (Aroclor 1260)	0.02 — 0.2
	4,4'-DDD	0.004 — 0.5
	Dieldrin	0.002 — 0.02
Sunfish	PCBs (Aroclor 1254)	0.02 — 0.5 (1.9)*
	4,4'-DDD	0.003 — 0.3
	Dieldrin	0.001 — 0.01
Carp	PCBs (Aroclor 1260)	0.1 — 3.5
	4,4'-DDD	0.04 — 9.7
	Chlordane	0.01 — 1.1
Source: Tetra Tech 2000a; USFW 1995; USFW 1997; USFW 2000		
¹ Unless stated otherwise, the reported results are from USFW sampling conducted during 1993 and 1995. ² The Food and Drug Administration (FDA) requires that fish containing PCB concentrations in excess of 2 ppm (This is FDA's Tolerance level) and DDT (and its metabolites) concentrations in excess of 5 ppm in edible fish tissue be removed from commerce. * In April 1992, VDEQ conducted fish and shellfish sampling in portions of the Quantico Embayment. The maximum PCB concentration detected was 1.9 ppm wet weight in a whole body sample of sunfish. The maximum total DDT concentration of 1.9 ppm was also detected in the same sample.		

Evaluation of Potential Public Health Hazards

Environmental investigations at the Old Landfill at MCCDC Quantico have determined the site to be a source of contamination for the Quantico Embayment area. Chemicals have been detected in surface soil and groundwater samples collected at the landfill that are known to be associated with site-related disposal practices (e.g., PCBs from used transformers and DDT from the disposal of pesticides). Since the groundwater underneath the landfill is not being used and access to the site is restricted, ATSDR has determined there to be no completed human exposure pathway (i.e., people are not expected to come in contact with site-related contaminants) for soil, sediment, groundwater, and surface water. However, migration of contaminated soil, sediments, and surface water runoff has contaminated portions of the Quantico Embayment area and the fish, shellfish, and other biota that live in the embayment area. The accumulation of PCBs and

other site-related contaminants in fish and shellfish has the potential to impact people who fish from the Quantico Embayment area.

ATSDR concluded in its 1996 Health Consultation ***“that local consumption of fish and shellfish from the Quantico Embayment does not pose a public health hazard for the general public”***. The extent to which specific sub-populations consume fish from the Quantico Embayment and other contaminated waters near MCCDC Quantico has not been well documented. The Virginia Health Department’s fish consumption advisory is limited to one fish species (Channel catfish). This may not adequately protect people, especially anglers or other populations who consume large amounts of other fish species from the embayment area. Some populations (e.g., Asians and Native Americans) may eat other fish species such as carp and eels and tend to have higher fish consumption rates than the general population. Since fishing locations and fish consumption patterns in the Quantico Embayment area have not been studied, there is the potential for higher exposures to sub-populations in the community. Until additional sampling data is collected for other common edible species and more is known about the fishing habits in the Quantico Embayment area, ***ATSDR considers the consumption of fish by certain sub-population from the Quantico Embayment to pose an indeterminate public health hazard***. Additional support for this public health determination is provided below.

In response to VDEQ’s 1993 NOV, MCCDC Quantico issued an advisory restricting fishing from the Quantico Embayment area in 1996. The Virginia Department of Health (VDH) issued a fish consumption advisory for PCBs in April 1999. The advisory includes portions of the Potomac River and tributaries near MCCDC Quantico. Specifically, it is for the Virginia tidal waters from the Woodrow Wilson Bridge downstream (~33 miles) to Brent Point at the mouth of Aquia Creek, particularly in the areas of Chopawamsic, Quantico, and Powell Creeks and Quantico Embayment (VDH 1999) (Figure 6). The advisory recommends not eating more than one eight-ounce meal per month of channel catfish larger than 18 inches.

On the basis of a review of all available fish sampling data, ATSDR supports the continued fish consumption advisory for the portions of the Potomac River specified above. However, the data ATSDR reviewed suggest that the advisory could be expanded to include other species (e.g.,

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carp and American eel). PCB concentrations in samples of whole body carp and eel collected from tributaries of the Potomac River have exceeded the health-protective value of 1 ppm based on maximum consumption rates of 12 meals per year (skinned and trimmed raw fish fillets) or 6 meals per year (whole fish) from the Quantico Embayment. ATSDR believes that this is probably the high end (I.e., very health-protective) of a realistic consumption rate for people who consume fish from the embayment area. ATSDR assumes the consumption of whole fish when calculating recommended maximum consumption rates. Although whole body tissue samples tend to overestimate the amount of a contaminant that people would be exposed to since people usually do not eat the whole fish uncooked, some ethnic groups may consume the whole fish and uncooked fish as a traditional practice.

The most recent fish sampling data available for review was collected in 1995. There are still some data gaps with respect to other commonly consumed fish species from the Quantico Embayment area (e.g., bass, trout, or yellow perch). Catfish are likely to contain higher levels of PCBs compared to most other species because of their feeding habits (i.e., bottom feeders) and are an appropriate indicator species (i.e., edible species that are likely to accumulate high PCB concentration in the aquatic food chain). Limiting the fish consumption advisory to only channel catfish, however, may result in people underestimating the risks from consuming other species that may also be contaminated.

MCCDC Quantico has previously posted “no fishing” signs warning against ingesting fish and shellfish species that are caught in the Quantico Embayment along the MCCDC Quantico boundaries (MCCDC 2003). The extent to which these signs prevent people from fishing in the embayment area is not known. According to the Virginia Department of Game and Inland Fisheries (VDGIF), people continue to fish in some areas of the embayment as well as other tributaries that have been impacted by site-related contaminants. It is possible that the “no fishing” signs are not noticed or may simply be ignored by anglers. During ATSDR’s 2003 site visit signs did not appear to be posted along the Quantico Embayment shoreline and apparently have been removed.

ATSDR presented maximum consumption guidelines for the fish and shellfish species that were sampled from the Quantico Embayment area in the 1996 Health Consultation (see Appendix H). Table 7 provides a summary of ATSDR’s recommended maximum consumption rates for the edible fish and shellfish species sampled in the Quantico Embayment. The table includes channel catfish, which were sampled after ATSDR released the 1996 Health consultation.

Table 7: Recommended Maximum Consumption Rates for Fish/Shellfish from the Quantico Embayment of the Potomac River					
Chemical	Average Concentration (ppm)	Number of Samples Detected	Health-based Screening Value (mg/kg/day)	Recommended Maximum Consumption (meals/year) Adult ¹	Recommended Maximum Consumption (meals/year) Child
Blue Crab					
Total PCBs	0.07	3/5 samples	0.00005	80	39
Total DDT	0.03	5/5 samples	0.0005	2241	1089
Sunfish					
Total PCBs	0.12	10/10 samples	0.00005	36	17
Total DDT	0.14	10/10 samples	0.0005	397	193
Yellow Perch					
Total PCBs	0.2	10/10 samples	0.00005	29	14
Total DDT	0.11	10/10 samples	0.0005	519	252
Eels					
Total PCBs	0.99	10/10 samples	0.00005	6	3
Total DDT	0.54	10/10 samples	0.0005	104	50
Carp					
Total PCBs	1.47	10/10 samples	0.00005	4	2
Total DDT	0.70	10/10 samples	0.0005	80	39
Channel Catfish					
Total PCBs	1.7	10/10 samples	0.00005	3	2
Total DDT	0.3	10/10 samples	0.0005	187	91
Notes:					
1. The recommended maximum consumption rates are based on assumptions and reference doses associated with non-cancer health effects					
Reference: Anderson, H.A., Amrhein, J.F., Shubat, P. and Hesse, J. Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory. September 1993.					
Guide for Anglers and other Fishing Populations:					
Consumption Category			Species from the Quantico Embayment		
<i>Category 1 (Unlimited Consumption [or up to 225 meals per year])</i>			None of the fish/shellfish from Quantico Embayment		
<i>Category 2 (1 meal per week):</i>			Blue Crab		
<i>Category 3 (1 meal per month):</i>			Sunfish and Yellow Perch		
<i>Category 4 (Up to 6 meals per year):</i>			Eel		
<i>Category 5 (Should not consume):</i>			Carp and Channel Catfish		

Table 7 shows that, with the exception of carp and channel catfish, most adults who are only occasional (i.e., less than 6 times per year) recreational fishers will not exceed these safe consumption guidelines. For example, blue crab (*Callinectes sapidus*), a commonly consumed shellfish species, was found to contain low concentrations of PCBs in the muscle tissue and most people would not come close to exceeding the consumption guideline for adults (80 [8 oz] meals per year). Eel, which contained PCB concentrations almost 5 times higher than what was detected in sunfish or yellow perch, is safe if six meals per year or less are consumed. However, not all commonly harvested fish species have been sampled. As a result of these data gaps along with uncertainty about the extent to which specific sub-populations may have a higher consumption rate (e.g., subsistence anglers) of fish from the Quantico Embayment, ATSDR concludes that for certain ethnic subgroups or high end consumers, the consumption of fish from the Quantico Embayment area is an indeterminate public health hazard.

According to representatives from the VDGIF, the likely source of fish consumption advisory information for the angler is a fishing regulations booklet containing fish advisory notices issued by the VDH. The booklets are distributed by the VDGIF to all approved outlets that sell fishing licenses in the state of Virginia (Fred Leckie, Assistant Director of Fisheries, VDGIF, Personal Communication, August 12, 2003). Fish advisory information is also posted on the Internet. For example, the Interstate Commission on the Potomac River Basin (ICPRB) includes information on their website about fishing advisories along portions of the Potomac River.

IV. Community Health Concerns

ATSDR identified community health concerns through discussions with community members, state and local officials, and MCCDC Quantico personnel, and through review of site documents, including RODs and Community Relations Plans.

- ***Potential for metal and organic residue bioaccumulation in game animals from former and current firing range activity***

Issue: Have site-related contaminants accumulated in the edible tissues of free-range game animals at MCCDC Quantico at levels that could pose a public health hazard to people who consume them?

Response: ATSDR is only able to provide a qualitative evaluation of public health risk from consuming game animals at MCCDC Quantico because wildlife samples have not been collected at the base. The data reviewed from published studies indicate that most contaminants do not readily accumulate in the lean muscle tissue of animals. Since only small portions of the base contain contaminants that would accumulate in wild life and there is no evidence that hunters at MCCDC Quantico rely on game meat for subsistence purposes, ATSDR believes it is very unlikely that consumption of most species of wildlife at MCCDC Quantico would pose a health concern. However, until actual sampling shows that they are safe to eat, ducks and other waterfowl that typically accumulate PCBs and other chlorinated pesticides should not be harvested in locations that are currently under fish advisories. As an added precaution to minimize any exposure to contaminants that typically accumulate in wildlife, ATSDR recommends removing the skin, trimming fat, and avoiding organ meats such as the liver and kidney in game animals. Additional information to help place ATSDR's conclusions and public health recommendations in better perspective are provided below.

MCCDC Quantico supports a large and diverse wildlife population. A large portion of the land owned by MCCDC Quantico is range or forested land (approximately 60,000 acres) and has not been significantly impacted by site-related contaminants. Wildlife samples have not been collected and analyzed for contaminants at MCCDC Quantico. However, ATSDR has evaluated

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the most current information on hunting activities compiled by the base's Natural Resources and Environmental Affairs Branch and has reviewed literature regarding the uptake and accumulation of contaminants in wildlife to help address any concerns about consuming wildlife on MCCDC Quantico property.

The Natural Resources Management Division (NRMD) at MCCDC Quantico is responsible for the management and conservation of fish and wildlife. A license is required in order to fish, hunt, or trap wildlife on MCCDC Quantico property. These licenses are available to military and civilian personnel working on the base as well as the surrounding community (MCCDC 2003). According to information compiled by the base, between 3,000 and 4,000 hunting licenses are purchased each year at MCCDC Quantico. Deer are the most common game animal hunted at MCCDC Quantico. An average of about 1,000 deer are hunted each season at MCCDC Quantico (approximately 40% of all the animals harvested annually). Squirrels and ducks combined represent an additional 40% of the annual harvest with turkeys, rabbits, and other birds (e.g., dove and geese) comprising most of the remaining harvest (MCCDC 2003).

The primary route of exposure of wild animals in contaminated areas is through the food chain (Syakalima et. al., 2001; Lewis et al., 2001). Waterfowl (e.g., ducks) and other wildlife (besides fish and invertebrates) may be impacted by contaminants entering the food chain. Although most portions of MCCDC Quantico are not contaminated, it is possible that wildlife may occasionally feed or nest in some of the contaminated portions of the base. The most likely sources of exposure for wildlife at MCCDC Quantico are from the FRR (Site 20) and the Old Landfill (Site 4). Lead shot from range activity has contaminated portions of The FRR. Lead and other site-related contaminants (e.g., antimony and copper) accumulate in soil and the food chain (e.g., game animals) and can be a potential pathway of exposure for hunters and people who eat game animals from MCCDC Quantico. Contamination at the Old Landfill has been well documented and the migration of contaminants via sediment and surface water runoff into the estuaries, creeks, and other surface waters associated with the Potomac River has been extensively studied.

There are numerous published studies that have sampled a large range of contaminants in different wildlife species (Science and Environmental Bulletin 2002; Lewis et al. 2001; EPA

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1999; USACHPPM 1995; USAEHA 1994). These studies generally demonstrate that chlorinated compounds (e.g., PCBs, DDT, and dioxins) and metals, with some exceptions (e.g., mercury), do not readily accumulate in muscle tissue (USAEHA 1994). The liver appears to be the most significant reservoir for lead and chromium in terrestrial and aquatic wildlife. Contaminants may also accumulate in the fatty tissues (PCBs, dioxins, and chlorinated pesticides), bone and hair (lead and arsenic) and kidney (cadmium) of animals.

ATSDR does not believe that consumption of wildlife at MCCDC Quantico poses a health concern to hunters because hunting of most game animals on base is seasonal and only hunters with permits are allowed access to MCCDC Quantico property. Since consumption of game animals at MCCDC Quantico is not for subsistence purposes, it is very unlikely that contaminants would accumulate in people at levels that would be harmful. Additionally, deer comprise approximately half of all the game harvested at MCCDC Quantico. Deer are herbivores and typically have very low concentrations of chlorinated compounds and metals in their muscle tissue. However, absent actual sampling data, we believe it is prudent to avoid portions of the animal that are most likely to accumulate contaminants such as the liver and other organ meats.

V. Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive to exposures than adults in communities with contamination in water, soil, air, or food. This sensitivity is the result of a number of factors. Children are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. Children are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children are also smaller, potentially resulting in higher doses of chemical exposure per unit body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

ATSDR has attempted to identify populations of children in the vicinity of MCCDC Quantico. According to base representatives, approximately 1,000 children under the ages of 10 reside in on-base housing and about 60 percent of those children are under 5 years of age (Fred Sullivan, Director of Family Housing, Personal Communication, January 29, 2003). A child development center (CDC) with a capacity of 290 (ages 6 weeks to 5 years old) was opened in August 1995. In addition there is a youth center, three elementary schools (Ashurst, Burrows, and Russell), and one middle high school (Quantico High School) on base (Roberta Simpson, Assistant Director of Child Development, Personal Communication, July 16, 2003).

As discussed in the “Evaluation of Environmental Contamination and Potential Exposure Situations” section of this PHA, the potential for children to be exposed to lead exists from coming into contact with contaminated soil at the FRR and from lead-based paint in older base housing. Children are tested for lead (i.e., blood lead screening) as part of the routine wellness exams. Older housing at MCCDC Quantico is being phased out and most of the older housing units will be replaced by new or renovated housing. MCCDC Quantico has released an Engineering Evaluation/Cost Analysis for Site 20 (FRR) and the report recommends excavation and off-site disposal of contaminated soil at the FRR.

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As a result of ongoing activities at MCCDC Quantico to remove potential sources of lead contamination, exposures to lead are not likely to pose a current or future public health hazard for children living on base. Although portions of the FRR contain very high levels of lead in the surface soil, the site is heavily vegetated and occasional access to the site by children would not likely be sufficient to result in harmful exposures. However, any contact with lead by children should be minimized and ATSDR has provided specific recommendations to help reduce any potential exposures to lead from unauthorized access to the FRR. These recommendations are provided in ATSDR's Public Health Action Plan (Section VII).

VI. Conclusions

After evaluating available environmental information, ATSDR has reached the following conclusions regarding identified exposure situations at MCCDC Quantico. ATSDR has not identified any past, current, or future public health hazards associated with site-related contaminants at MCCDC Quantico. ATSDR classifies these exposure situations as no apparent public health hazard. ATSDR's conclusions regarding the potential exposure pathways evaluated at MCCDC Quantico are described in more detail:

1. **Lead-contaminated soil at the FRR (past, current and future exposures): *Potential current, and future exposures to lead in surface soil are not a public health hazard for children living in base housing.*** ATSDR identified potential past exposure pathways associated with the FRR. Most notably, surface and subsurface soil at all of the ranges within Site 20 are contaminated with lead. Our evaluation indicates that although the FRR was accessible to children in the past, the portions of the site where elevated lead levels have been found (e.g., bermed areas) are heavily vegetated and not likely to be a completed pathway of exposure. Even if children were to trespass onto the FRR, it is unlikely that occasional contact with surface soil alone at the site will result in sufficient exposure to cause harm. *ATSDR classifies this exposure pathway as “no apparent public health hazard”*

Exposures to lead in surface soil did not pose a public health hazard for children living on base in the past. Although ATSDR has identified potential exposure pathways at the FRR, there is no evidence that children or adults were accessing the range frequently in the past. Most of the FRR was covered by vegetation that would have reduced any potential contact with surface soil by children or other trespassers. It is unlikely that occasional contact with surface soil alone at the site would have resulted in sufficient exposure to cause harm. ATSDR has classified this exposure pathway as a “no apparent public health hazard.”

2. **Lead and asbestos in family housing (past, current, and future exposure):** *Current and future exposures to asbestos and lead in family housing do not pose a public health hazard.* Lead screening in children is routinely conducted at MCCDC Quantico and there have been no cases of elevated blood lead (i.e., blood lead levels above 10 ug/dl) identified in children living on base. The MCCDC Quantico housing office distributes information about lead hazards and provides educational materials about how to reduce potential exposures to lead. As part of the PPV for new housing at MCCDC Quantico, a large portion of the old housing is being replaced with new or renovated housing. This will eliminate any potential hazards in the future for children living in on-base housing.

It is unknown whether past exposures to asbestos or lead in family housing were a health hazard. Past exposure exposures to lead-based paint were possible. Due to the lack of sampling data it is unknown whether past exposure to asbestos occurred. Since information is not currently available to evaluate this past exposure, it is considered an indeterminate public health hazard.

3. **Contamination in the embayment area and other surface water bodies (past, current and future exposure):** *ATSDR concludes that local consumption of fish and shellfish from the Quantico Embayment does not pose a current or future public health hazard for the occasional recreational fisher. (Refer to Table 7 for species-specific maximum consumption recommendations).* ATSDR's evaluation of fish and shellfish sampling data from the Quantico Embayment area indicates that, with the exception of carp and channel catfish, recreational fishers will not be harmed by occasionally consuming (i.e., 6 [8 oz] meals or less) most commonly consumed fish or shellfish species from the Quantico Embayment area. ATSDR has classified the current and future consumption of fish from the Quantico Embayment as a "no apparent public health hazard."

ATSDR concludes that past consumption of fish and shellfish from the Quantico Embayment did not pose a public health hazard for the occasional recreational fisher. Fish and shellfish were only sampled from the Quantico Embayment in the last ten years. Based on the relatively small range of PCB concentrations in the fish and shellfish samples that have been collected, it is unlikely that levels in the past would have been high enough to pose a health hazard for people consuming fish from the Quantico Embayment. The average concentrations in the most contaminated species (i.e., catfish and carp) did not exceed one order of magnitude (i.e., the lowest concentration was not more than 10 times the maximum concentration) above ATSDR’s conservative health-based guideline for PCBs, assuming a person eats one (8 oz) fish meal per week from the Quantico Embayment. ATSDR has classified past consumption of fish from the Quantico Embayment as a “no apparent public health hazard.”

ATSDR considers the consumption of fish by certain sub-populations (e.g., ethnic groups or subsistence anglers that catch and consume fish more than the general population) from the Quantico Embayment to pose an indeterminate public health hazard. The extent to which specific groups frequently consume fish from the Quantico Embayment and other contaminated waters near MCCDC Quantico has not been well documented. The Virginia Health Department’s fish consumption advisory is limited to one fish species (Channel catfish) greater than 18 inches in length. This may not adequately protect people, especially anglers or other populations who frequently consume smaller catfish or large amounts of other fish species from the Quantico Embayment area. Until additional sampling data is collected for other common edible species and more is known about the fishing consumption patterns of certain sub-populations in the area a public health determination cannot be made.

VII. Recommendations

Based on the conclusions about potential exposure pathways at MCCDC Quantico, ATSDR makes the following recommendations.

1. ATSDR recommends that renovated housing units undergo confirmatory lead testing prior to occupancy to ensure that all lead hazards have been removed.

2. ATSDR continues to support the recommendations presented in its October 1996 health consultation, specifically that:
 - If fishing in the embayment area does occur, consumption should not exceed maximum recommended consumption rates (refer to Table 7) for the species sampled and analyzed;

 - More commonly consumed species (e.g., trout, striped bass or largemouth bass) should be sampled and analyzed for PCBs, DDT, and its breakdown products to ensure that contaminant concentrations are not at levels of health concern; and

 - All fish obtained from the Quantico Embayment and Potomac River should be skinned, trimmed of fat, and cooked (e.g., allowing fat and oils to drain off) in a manner that minimizes exposure to organic chemical contaminants.

In addition, ATSDR recommends that people adhere to the fishing advisory issued by the VDH for the Quantico Embayment and other sections (or tributaries) of the Potomac River.

VIII. Public Health Action Plan

The public health action plan (PHAP) for MCCDC Quantico contains a description of actions to be taken by ATSDR and other government agencies at and in the vicinity of the site upon completion of this PHA. The PHAP is designed to ensure that this PHA not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The plan includes a commitment on the part of ATSDR to follow up and ensure that the plan is implemented. The public health actions completed and to be implemented are as follows:

Completed Actions

1. *Former Rifle Range:*

- Site evaluations beginning in 1988 have been conducted for the FRR.
- An RI was initiated at Site 20 in October 1997 and additional data gap sampling was conducted in 2000 and again in 2002.
- An Engineering Evaluation/Cost Analysis for Site 20 was released in July 2003. This report identified and evaluated several options for addressing soil contaminated with lead and other site-related contaminants.

2. *Lead-based paint in family housing:*

- In July 1997, MCCDC Quantico conducted a Family Housing Lead and Asbestos Assessment.

3. *Contamination in the Quantico Embayment area:*

- An Initial Assessment Study was conducted in 1984 and a Confirmation Study was conducted in 1988.

- In 1990, PCB-contaminated soil was removed from the Defense Reutilization and Marketing Office (DRMO) Scrap Yard and the Transformer Storage Area.
- The DON installed a sediment control system consisting of silt fences, hay bales, and riprap in May 1994.
- In 1994/1995 an Engineering Evaluation/Cost Analysis (EE/CA) and Focused Feasibility Study (FFS) for an Interim Remedial Action (IRA) was completed.
- Between May 1996 and October 1997 IRA activities were completed. These activities included the removal of sediment from the drainage channel, removal of sediment and waste material from the Quantico Embayment, removal of DRMO structures and surface debris, installation of soil barrier layer over the landfill, and installation of shoreline protection.
- An RI to support the final remedial action was conducted between 1997 and 2000.

Ongoing or Planned Actions

1. *Former Rifle Range:* MCCDC Quantico is planning on conducting a soil removal action for the FRR. The action may take place at the end of 2003 or early part of 2004.
2. *Lead-based paint in family housing:* A public-private venture (PPV) initiative at MCCDC Quantico will result in an estimated 1,137 new and renovated housing units with construction scheduled to begin in September 2003. All non-renovated units will be demolished.
3. *Contamination at the Old Landfill and the Quantico Embayment area:* the DON in cooperation with U.S. EPA Region 3 and VDEQ is conducting The Quantico Watershed

Study. Groundwater will continue to be monitored from the Old Landfill to the Potomac River and Embayment area. A feasibility study has been proposed to characterize the nature and extent of sediment contamination in the Quantico Embayment area.

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APPENDICES



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Sites Identified During Initial Assessment Study and Recommended for a Confirmation Study or Additional Evaluation				
Pesticide Burial Area (Site 1)	<p>The pesticide burial area, located in the eastern third of MCCDC Quantico, consists of a pit approximately sixteen feet in diameter and eight feet deep.</p> <p>The pesticides that were reportedly disposed of at the burial area included lead arsenate, micosulfer, dieldrin, paris green, captan, and kelthane. Dieldrin and kelthane were in liquid form and the rest were disposed of as solids.</p>	<p>A confirmation study was conducted in two phases. The verification phase (Phase I) was conducted from 1985 through 1986. The characterization phase (Phase II) was conducted from 1987 through 1989. An RI and Feasibility Study (FS) were conducted between October 1991 and August 1992. An RI was conducted in February 1997.</p> <p>Three monitoring wells were installed at the Pesticide Burial Area in November 1991. Quarterly groundwater samples were collected for one year. The samples were analyzed for selected pesticides/polychlorinated biphenyls (PCBs), captan, kelthane, arsenic, and lead.</p> <p>Conclusions drawn in the initial assessment study, confirmation study, and preliminary RI indicated that buried waste and associated contaminated soils were the primary media of concern.</p> <p>Groundwater: No pesticides or PCBs were detected in any of the groundwater samples. Lead (22 parts per billion [ppb]) and arsenic (2.1 ppb) were detected in groundwater samples.</p> <p>Surface Soil: Arsenic was detected in surface soil at a maximum concentration of 3.5 parts per million (ppm). Pesticides were not detected in surface soil above ATSDR's CVs.</p>	<p>The Pesticide Burial Area was excavated in June 1974 for a one-time disposal of waste pesticides from the Pest Control Shop (Building 668).</p> <p>A removal action was conducted in 1994 based on previous sampling indicating elevated levels of arsenic in soils near the expected location of the Pesticide Burial Area. Approximately 137 tons of pesticide-contaminated soil were excavated and disposed during the removal action. A total of 15,800 gallons of contaminated water that had accumulated in burial pit from rain and melting snow was collected and disposed of.</p> <p>Based on the results of confirmation sampling, the MCCDC Quantico Project Managers Team (QPMT) agreed that no further action was required for this site.</p>	<p>The Pesticide Burial Area does not pose a public health hazard because contaminants are not present at levels of health concern.</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Old Landfill (Site 4)	<p>The Old Landfill is an eight-acre site located on the Potomac river shoreline east of Building 672. All tenants at the base used the landfill from approximately 1920 until 1971.</p> <p>Open burning operations were conducted on a daily basis and it is estimated that 10,000 gallons of paint, 6,000 gallons of paint thinner, and 120 gallons of PCBs from electrical transformer disposal were deposited in the landfill during the period of operation.</p> <p>Soil from the landfill was moved around considerably during the operation of the landfill and construction of the berm area. This transfer of soil has largely contributed to the widespread contamination of the landfill.</p> <p>In June 1993, the Virginia Department of Environmental Quality (VDEQ) issued a Notice of Violation for the Old Landfill site. VDEQ found MCCDC Quantico to be in violation of water quality standards for surface water and groundwater resulting in environmental damage (PCBs in fish tissue).</p>	<p>A confirmation study report was released in June 1988. During the confirmation study nine groundwater monitoring wells (MW) (MW-1 to MW-9) were installed around the perimeter of the bermed area of the landfill.</p> <p>Surface soil samples were collected from nine locations inside the berm area and analyzed for PCBs and total organic carbon (TOC). Two additional soil samples were collected in the vicinity of the reported dumping of PCB-containing dielectric fluid in the DRMO scrap-yard. Subsurface soil samples were collected at varying depths from each monitoring well. The seven samples were analyzed for PCBs/Pesticides and TOC.</p> <p>An RI was conducted during 1997/1998 and included surface soil, subsurface soil, groundwater, sediment, and seep sampling.</p> <p>US Fish and Wildlife Service conducted fish tissue sampling in 1993 and 1995.</p> <p>Soil: Most samples contained less than 1 ppm PCBs in surface soil. The sample of soil from the scrap-yard contained 170 ppm of PCBs. DDE (260 ppm), DDD (1,200 ppm), and DDT (150 ppm) were detected in soil samples.</p> <p>PCBs were detected in the subsurface soil samples collected at MW-2 (1,100 ppb) and MW-3 (2,800 ppb). Other soil samples contained PCBs at a maximum concentration of 5,300 ppm.</p>	<p>Interim remedial action (IRA) (1997) and post-IRA (2002) studies were conducted for the Old Landfill.</p> <p>During these remedial studies, the following activities took place:</p> <ul style="list-style-type: none"> • PCB-contaminated sediment was removed from a drainage canal, • Waste material and sediment from the Quantico Embayment was removed and placed in the landfill, • PCB-contaminated soil in the DRMO scrap-yard and the DRMO storage area was removed, • A fence was installed around the perimeter of the landfill, • Geotextile fabric was placed between the debris and barrier layer, 	<p>The Old Landfill does not pose a public health hazard for the soil, groundwater, or surface water pathway. Ground water beneath the base is not used for drinking or other domestic uses and access to the landfill is restricted to authorized personnel only. Clean-up activities include the removal of PCB-contaminated soil, and sediments from the drainage canal at the landfill and placement of a cap over the landfill to prevent further migration of contaminants into the Quantico Embayment.</p> <p>ATSDR believes that local consumption of fish and shellfish from the Quantico Embayment does not pose a public health hazard for the general population.</p> <p>ATSDR considers the consumption of fish by certain sub-population from the Quantico Embayment to pose an indeterminate public health hazard. The extent to which specific sub-populations who frequently</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
	<p>In 1988, a pipeline along the western boundary of the landfill ruptured and released approximately 100,000 gallons of fuel oil. Between 5,000 and 6,000 gallons of fuel were recovered.</p>	<p>Lead (9,910 ppm) and arsenic (52 ppm) were detected above ATSDR's CVs.</p> <p>During the RI, pesticides and PCBs were not detected in soil samples at levels above ATSDR's CV.</p> <p>Groundwater: A sample from MW-3, the well closest to the DRMO Scrap yard, contained 1.7 ppb of PCB-1260.</p> <p>Arsenic (207 ppm), Lead (10,800 ppm), Vinyl chloride (22 ppb), chlorobenzene (280 ppb), and benzene (9.1 ppb) were detected above ATSDR's CVs in groundwater samples. Total petroleum hydrocarbons (TPHs) were also detected in groundwater at 47,800 ppb.</p> <p>Surface Water (i.e., seeps): No contaminants were detected in seep samples above ATSDR's CVs.</p> <p>Sediment: Aroclor 1260 was detected in sediment at 2.3 ppm.</p> <p>Biota: PCBs and pesticides were detected above FDA's 2 ppm tolerance level in several species of fish sampled in the Quantico Embayment area.</p>	<ul style="list-style-type: none"> • A soil barrier covering (Twenty-four inches of soil, including six inches of topsoil) was placed over the landfill, • The riverbank adjacent to the landfill was stabilized, and • Silt fences, hay bales, and berms were installed to prevent contaminated sediment from migrating. <p>A feasibility study is being finalized for the long-term monitoring of groundwater and expected to begin in fiscal year 2005. MCCDC Quantico is conducting a feasibility study for pesticide-contaminated sediments. MCCDC Quantico expects to complete the study in Fall 2004.</p>	<p>consume fish from the Quantico Embayment and other contaminated waters near MCCDC Quantico is uncertain. The Virginia Health Department's fish consumption advisory is limited to one fish species (Channel catfish) and may not be health protective for everyone (e.g., anglers or other populations who frequently consume smaller catfish or large amounts of other fish species from the Quantico Embayment area). Until additional sampling data is collected for other common edible species and more is known about the fishing consumption patterns of certain groups in the area a public health determination cannot be made.</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Old Batch Plant (Site 5)	<p>The Old Batch Plant site consists of an area approximately 30 feet by 50 feet located in the eastern portion of the base, about 10,000 feet south of the Old Landfill.</p> <p>The site is actually an old disposal area that is located near an old concrete mixing plant about 100 feet northeast of Building 3218.</p> <p>Unserviceable electrical transformers from the Electrical Shop accumulated in open storage at the site from the early 1970's until 1979.</p>	<p>A confirmation study report was released in June 1988. Field sampling was conducted in October 1997 as part of an RI.</p> <p>Twenty-three of the 34 transformers removed during a 1979 removal action contained PCBs. Concentrations in the oil ranged from 3 parts per million (ppm) to 100 percent PCB.</p> <p>A composite soil sample was collected during the Initial Assessment Study (IAS) and PCBs were detected in the sample.</p> <p>Soil, surface water, groundwater, and sediment samples were collected at this site and analyzed for PCBs and selected pesticides during the RI.</p> <p>Surface Soil: Aroclor 1260 (620 ppm) and some pesticides (e.g., DDT at 3.5 ppm) were detected in surface soil.</p> <p>Groundwater: No pesticides or PCBs were detected in any of the groundwater samples collected.</p> <p>Surface Water and Sediment: No contaminants were detected above ATSDR's CVs in surface water. DDT (2 ppm) and associated breakdown products were detected in sediment samples.</p>	<p>A total of 34 transformers were removed from the site in 1979</p> <p>A removal action was conducted in December 1990 to excavate the source of PCB contamination.</p> <p>The concrete pad and approximately 1 foot of soil from adjacent areas were removed. Confirmatory soil samples were collected in October 1991 and PCBs were not detected.</p> <p>The site was recommended for a designation of "no further action."</p>	<p>The Old Batch Plant does not pose a public health hazard because contaminants are not present at levels of health concern.</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Brown Field Underground Fuel Storage Area (UFSA) (Site 6)	<p>The Brown Field UFSA is located in the southeastern corner of the base at the junction of Elrod and Engineer's roads. Marine Corps Air Station Turner Field is located approximately 1/2 mile north-northeast of the site, and the Potomac River is located within 1,000 feet to the east.</p> <p>The UFSA consists of 5 underground fuel storage tanks aligned approximately east west within a 3-acre area along the northern side of Engineer's Road. The four easternmost tanks (Tanks 2143-2146, east to west) each have a capacity of 101,000 gallons. Tank 2147, the westernmost tank, has a capacity of 250,000 gallons.</p> <p>In 1978, a release of jet propulsion (JP)-4 fuels was discovered. The source of this release was identified as underground storage tanks (USTs) in close proximity to the Brown Field area.</p> <p>The fuel farm has been inactive since 1985. The area is currently an open field used as part of an obstacle course by the Marines.</p>	<p>A PA/SI was conducted for this site.</p> <p>Eleven monitoring wells were installed to determine the nature and extent of groundwater contamination in the area around the Brown Field site.</p> <p>Soil, groundwater, surface water, and sediment samples were collected and analyzed for petroleum related compounds.</p> <p>Surface Soil: TPH (95 ppm) was detected in subsurface soil samples.</p> <p>Groundwater: Benzene (960 ppb) was detected above ATSDR's CV.</p> <p>Surface Water: No contaminants were detected above ATSDR's CVs.</p> <p>Sediment: TPHs were detected at a maximum concentration of 4,600 ppb in sediment samples.</p>	<p>The results of the Site Investigation Report indicate no evidence of previous hazardous waste storage in any of the underground tanks.</p> <p>In 1985, all tanks were removed from service. The product was removed and the inside of the tanks cleaned before being backfilled with sand.</p> <p>Contamination at this site consists entirely of petroleum related products. Therefore, the site is being addressed under the Virginia UST program.</p> <p>In October 1997, contamination was discovered near the Brown Field site across the road. It was determined that the abandoned piping system was causing the contamination. The old piping was removed along with contaminated soil and water at the location that contamination was identified.</p> <p>In May 1988, approximately 500 cubic yards of petroleum-contaminated soils were removed. MCCDC Quantico received a notice of site closure in July 1998.</p>	<p>The Brown Field UFSA (Site 6) does not pose a public health hazard because; 1) the groundwater is not used for drinking or for any other purpose; and 2) contamination was not detected in soil at levels that would be of health concern.</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
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Recently Closed Landfill (Russell Road) (Site 7)	<p>This landfill is a 28-acre site located in the eastern third of the base, 300 yards north of the intersection of Interstate Route 95 and Russell Road.</p> <p>The site was used from 1971 until it was closed in June 1983. This site was the official base landfill and was used by all tenants at MCCDC.</p> <p>Approximately 27,000 gallons of paint and 16,000 gallons of paint thinner and cleaners were disposed in the landfill. Other waste reportedly disposed in the landfill include waste oils, automobile batteries, photographic film and chemicals, construction debris, tires, scrap metal, brush, and tar.</p>	<p>A confirmation study report was released in June 1988. During the confirmation study, five groundwater monitoring wells were installed around the perimeter of the landfill.</p> <p>Liquids were observed leaking from the landfill and samples indicated that the landfill is leaching organic compounds.</p> <p>Groundwater: Some volatile organic compounds (VOCs) were detected above ATSDR's CVs. PCBs and pesticides were detected at very low concentrations.</p> <p>Surface Water: No VOCs were detected at harmful levels in surface water samples from seeps.</p>	<p>In accordance with the approved Erosion and Sediment Control Plan, June 1995, approximately 9,000 feet of silt fence was installed around the perimeter of the landfill.</p> <p>Sediment traps, sediment basins, and leachate collection trenches were also placed at the landfill. A cap was placed over the landfill and MCCDC Quantico received clean closure approval in April 2003.</p>	<p>The Russell Road Landfill does not pose a public health hazard because contamination has been detected mostly in groundwater, which is not used as a drinking water source.</p>
CER Battery Acid Disposal Area (Site 13)	<p>The Battery Acid Disposal Area is located near the central portion of the base, in the vicinity of the Construction Equipment Repair Shop.</p> <p>The site consists of a 2400 square-foot open tract of land primarily covered with grass; however, a small area on the north end is covered with crushed stone. A chain link fence runs west to east across the</p>	<p>A confirmation study report was released in June 1988.</p> <p>In 1995, site contractors (OHM Corp) excavated and disposed of the top 2-feet of soil from the battery acid disposal area. Ten confirmatory soil samples were collected from the area of concern and four background soil samples were collected from a location approximately 100 feet west of the disposal area. The ten soil samples collected in the area of concern were obtained from a depth of 2-feet below ground surface.</p>	<p>In 1985, a 200 square-foot area was excavated to an unknown depth. The excavated soils were mixed with lime for pH adjustment and placed back into the excavated area.</p> <p>A site closure report was released in May 1994. Preparation of this plan was ordered by the USEPA Region III, and was developed to attempt a clean closure of the</p>	<p>The CER Battery Acid Disposal Area does not pose a public health hazard because lead concentrations detected in soil are below levels of health concern.</p>



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
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	<p>northern third of the disposal area. A heavily wooded area and several small streams are located to the south. The disposal area appears to slope toward the south and surface water appears to drain into several small streams.</p> <p>From 1970 to 1983 lead-acid batteries from construction equipment in the shop were drained onto the ground. Approximately 75 to 80 batteries were emptied annually containing an estimated cumulative total of 7 pounds of lead.</p>	<p>Confirmatory samples showed that the highest lead concentrations (13 ppm) were well below EPA's action levels for lead in soil.</p>	<p>battery acid disposal area in accordance with the Virginia Hazardous Waste Management Regulations 1990 (40 CFR 264).</p> <p>Post excavation sampling showed that lead concentrations were not at levels that would warrant any further remedial action and no further action at the site is anticipated.</p>	



Appendix A: Evaluation of Public Health Hazards Associated with Source Areas at MCCDC Quantico				
Sites	Site Description/Waste Disposal History	Investigation Results/ Environmental Monitoring Results	Corrective Activities	ATSDR Evaluation of Public Health Hazards
Arsenic Burial Area (Site 17)	<p>This site is located in the eastern portion of the base, just southwest of the Old Batch Plant.</p> <p>This was the site of a one-time burial occurring around 1970. It was reported that 27 30-gallon drums from the Pest Control Shop labeled “arsenic of lead” were stacked in the bottom of a 10-foot deep trench covered with soil. The buried product was believed to be sodium arsenite, used for weed control along the MCCDC Quantico fence-lines.</p> <p>Site 17 was originally believed to be southeast of the Installation Correctional Facility (Building 3247), and south of Building 3237. However, no evidence-of disposal has been identified at this location. Two potential burial locations were subsequently identified: Site 17A, located near the former explosive bunker 2191, and Site 17B, located south of the original area along the fitness trail road and west of the railroad tracks.</p>	<p>An IAS, Confirmation Study (1986), and preliminary RI were performed at the Arsenic Burial Area. Soil and groundwater samples were collected during the confirmation study and preliminary RI and no confirming evidence was found to indicate that the Arsenic Burial Area existed in the location initially identified. Three phases of activity (i.e., sampling were conducted and incorporated into RI reports released in 1992 and 1998.</p> <p>Two suspected disposal areas (Sites 17A and 17B) were identified and investigated prior to a final determination of the site. A high-resolution electromagnetic geophysics survey was completed at Site 17A which concluded that it was not the location of the drum burial area. However, at Site 17B two drums were identified on the ground surface, each labeled with the words Sodium Arsenite, indicating a possible location for the drum burial area. The drums were in poor condition and their contents were unknown.</p> <p>Groundwater: Arsenic (17 ppb) and lead (244 ppb) were detected above ATSDR’s CVs.</p> <p>Surface Soil: Soil was analyzed for arsenic, lead, and TPH. Arsenic (11.1 ppm) was detected in surface soil above ATSDR’s CV. Low levels of arsenic and lead were also detected at sites 17A and 17B. However, levels did not exceed the maximum concentrations detected at Site 17.</p>	<p>Site contractors recommended groundwater monitoring for 5 years.</p> <p>No other corrective activities have been conducted.</p>	<p>The Arsenic Burial Area does not pose a public health hazard because arsenic concentrations detected in soil are below levels of health concern. Groundwater is not a source of drinking water for MCCDC Quantico.</p>



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Aero Club (Site 18)	<p>The Aero Club is a private flying club for base personnel located at the northeast end of the airfield, adjacent to the river. The airfield is built on artificial fill and borders on the Potomac River and Chopawamsic Creek</p> <p>Small single engine propeller driven aircraft received routine maintenance such as oil changes and fuel tank draining on the parking ramp and on the adjacent grass. The planes were also refueled in this area. The aviation fuel was stored in USTs. Spills may have occurred during refueling activities or other maintenance activities. These maintenance operations continue at the site today.</p>	<p>In 1982, a soil sample from this drum storage area was collected and analyzed as a part of an environmental survey conducted by the DON. The total lead content exceeded 1,000 ppm.</p> <p>Additional soil and groundwater samples were collected during the verification and characterization phases of the confirmation study.</p> <p>Between April 18 and May 3, 1994, additional surface and subsurface soil samples were collected at the Aero Club.</p> <p>Surface Soil: VOCs and SVOCs were detected in surface soil at levels below ATSDR's CVs. Arsenic (7.1 ppm) and lead (1,200 ppm) were detected above ATSDR's CVs.</p> <p>Groundwater: Lead was detected in unfiltered water at a concentration of 505 ppb.</p>	<p>In 1997, MCCDC Quantico conducted a removal action. The site was subsequently closed under the state UST program.</p>	<p>The Aero Club does not pose a public health hazard because most concentrations detected in soil are below levels of health concern. Lead was detected above EPA's action level for residential soil, however, the access to this area is restricted and only minimal contact with soil is expected.</p>



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Former Fire Training Area (Site 19)	<p>The Fire Training Area is located on the southwest end of the Marine Corps Air Station (MCAS) at Quantico.</p> <p>The base's Crash-Rescue crews used the Fire Training Area for semi-monthly training. The area was used from the mid-1960s through the early 1990s.</p> <p>Combustible liquids are burned to produce the fires for training purposes.</p> <p>The area is currently in use until construction of the new fire training facility is completed.</p> <p>The Fire Training Area was not one of the original 17 sites identified in the Initial Assessment Study conducted in 1984. It was added to the scope of the IRP Confirmation Study at the request of MCCDC Quantico personnel in 1985.</p>	<p>A confirmation study report was released in June 1988</p> <p>Between April 18 and May 3, 1994, surface and subsurface soil samples were collected from the former Fire Training Area.</p> <p>A total of six groundwater-monitoring wells were installed at the site to identify any impact on groundwater quality in the area.</p> <p>Surface and subsurface soil samples were collected from 14 locations around the fire-training pit and were analyzed for VOCs, SVOCs, PCBs, pesticides, and metals.</p> <p>Surface Soil: Lead (747 ppm at the pit and 640 ppm at perimeter) was detected above EPA's action level</p> <p>Low concentrations of VOCs and SVOCs were detected in surface soils below ATSDR's CVs. The maximum concentration of TPH in the surface soil samples was 12,900 ppm.</p> <p>Groundwater: No VOCs or SVOCs were detected above ATSDR's CVs. Lead (35 ppb) was detected in unfiltered samples above EPA's action level for lead in drinking water. TPH was detected in groundwater at a maximum concentration of 72 ppm.</p>	<p>A removal action occurred in 1997 to remove contaminated soil.</p>	<p>The Former Fire Training Area does not pose a public health hazard because most concentrations detected in soil are below levels of health concern. Lead in soil is above EPA's action level for residential soils, however access to the site is restricted and any contact with contaminated soil is expected to be minimal.</p>



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Former Rifle Range (FRR) (Site 20)	<p>The FRR covers approximately 30 acres west of Lejeune Hall near the southeastern portion of the base.</p> <p>The site consists of six former firing ranges (Range A–F) consisting of pistol, rifle, and skeet ranges. These firing ranges were used as the primary pistol and rifle training area for approximately 20 to 30 years. The skeet ranges (D and F) operated from the mid 1930’s through the early 1950’s. The pistol ranges (A and C) operated from the mid 1930’s through the mid 1960’s.</p> <p><u>Range A:</u> Range A: This area was used as a pistol range and is the southern-most range at the site. The area is approximately 200 feet in length and 200 feet in width.</p> <p><u>Range B:</u> This area lies along the northern edge of Range A and was used as a rifle range. Range B is approximately 600 feet in length and 100 in width.</p> <p><u>Range C:</u> This area lies along the northeastern edge of Range B and was used as a pistol range. Range C is approximately 200</p>	<p>An Environmental Assessment was conducted in 1988 and elevated lead was detected in soil. The Naval Civil Engineering Laboratory (NCEL) collected additional soil samples in 1988.</p> <p>In 1991, a site investigation and interim remediation evaluation was performed by ABB Environmental Services, Inc. A total of 88 surface soil samples, 18 subsurface samples, 2 background soil samples, 4 surface water samples, and 8 sediment samples were collected and analyzed for lead and copper.</p> <p>In 1993, a field investigation was conducted at the FRR. A total of 96 surface and 104 subsurface soil samples were collected during the investigation.</p> <p>An RI for the FRR was completed in 1999. During the RI, soil (surface and subsurface), surface water and seeps, and sediment samples were collected and analyzed for total lead, Toxicity Characteristic Leaching Procedure (TCLP) lead, and total copper. Some selected samples were analyzed for a larger suite of contaminants (e.g., VOCs).</p> <p>In September 2000 a field investigation was conducted to address data gaps from previous investigations. Fifteen surface soil samples and 15 subsurface samples were collected at locations where elevated lead was previously identified. Lead in surface soil ranged from 29 to 22,700 ppm.</p>	<p>The DON installed a sediment control system consisting of silt fences, hay bales, and riprap in May 1994.</p> <p>An Engineering Evaluation/Cost Analysis for Site 20 was released in July 2003. This report identified and evaluated several options for addressing soil contaminated with lead and other site-related contaminants. The report concluded that excavation and off-site disposal of the contaminated soil provides the best remedial alternative for this site. A soil removal action is expected to begin in 2004.</p>	<p>The FRR is accessible to children living at Argonne Hills, which is part of the on-base housing area at MCCDC Quantico.</p> <p>The FRR is vegetated with grass or brush covering a large portion of the site. It is unlikely that occasional access to the range area would result in harmful exposures to lead. However, since lead is highly toxic and can accumulate in the body MCCDC Quantico should ensure children do not have access to the range.</p>



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	<p>feet in length and 200 in width.</p> <p>Range D: This area is the northern-most range and was used as a skeet range for shotgun training. The range is approximately 200 feet in length and 200 in width. Three firing locations were present along the northern, eastern, and southern edges of the ranges.</p> <p>Range E: This area lies east of Ranges B and C across what used to be a small parking area. Range E was probably used as a short-distance pistol range. The range is the smallest of the six ranges and is approximately 30 feet in length and 130 feet in width.</p> <p>Range F: This area lies along the eastern edge of the site near Ranges A and B and was used as a skeet range for shotgun training. The range is approximately 150 feet in length and 75 feet in width. Three firing locations are present along the northern, western, and southern edges of the range.</p>	<p>In the fall 2002, a field (data gap) investigation was conducted to further delineate surface and subsurface soil contamination at Site 20. More than 300 surface samples and over 100 subsurface samples were analyzed for lead using X-Ray fluorescent (XRF) technology. Concentrations ranged from approximately 40 ppm to 2,562.</p> <p>Surface Soil: The maximum lead concentration detected in surface soil samples was 39,600 ppm (1 to 2 inches depth).</p> <p>Groundwater: The maximum lead concentration detected in groundwater was 5.7 ppb.</p> <p>Surface Water and Sediment: Lead was detected in sediment at 418 ppm and in surface water at 211 ppb [Note: 3,600 ppb total lead versus 13 ppb dissolved was detected in one surface water sample].</p>		



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Other "Initial Assessment Study (IAS)" Sites (Eleven additional sites were identified during the IAS, but not recommended for a confirmation study):				
Asbestos Burial Area (Site 2)	<p>This site is located in the central portion of MCCDC Quantico. This site was originally</p> <p>A one-time disposal of approximately 68 kilograms of asbestos from on-site welding shops was reported to have occurred in July 1976. According to site documents, the asbestos was contained in plastic bags, cardboard boxes, and a metal box, and was buried in a trench together with other construction debris (e.g., steel, wood, concrete, and wire rope).</p>	<p>This site was identified during the IAS. A site screening process investigation was conducted. No samples were collected at this site.</p>	<p>No asbestos was identified during the site screening process and the QPMT decided that this site would require no further action (NFA).</p> <p>A removal action was completed in May 2003. During this removal action asbestos was not found. However, some ordnance was excavated and disposed of. New soil was brought in where the partial removal occurred.</p>	<p>The Asbestos Burial Area does not pose a public health hazard because asbestos was not identified during the site investigation and any asbestos materials located at the site would be below the surface and not accessible.</p>
Calcium Dihydrate Burial Area (Site 3)	<p>This site is located in the central portion of MCCDC Quantico directly adjacent to the Asbestos Burial Area.</p> <p>In May 1977, 226 kilograms of a white substance was buried in a trench. The powder reportedly originated from a storage bunker in the Brown Field area. The substance was reported to be calcium dihydrate, however, this substance is not referenced in the chemical literature and the identity remains unknown.</p>	<p>The IAS evaluated this site for the presence of hazardous chemicals. No samples were collected at this site.</p>	<p>No corrective activities have been conducted. According to site documents, the material is not considered to be hazardous and the potential for the powder to migrate is very low.</p>	<p>The Calcium Dihydrate Burial Area does not pose a public health hazard because the substance is buried underground, is not expected to migrate, and does not appear to be hazardous.</p>



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[Brownfield] Underground Fuel Storage Area (UFSA) (Site 6)	<p>The UFSA consists of five tanks located approximately 1,200 feet from the Potomac River and about 6,000 feet south-southwest of the Old Landfill.</p> <p>The USFA was in active use from the 1940s to 1984. In November 1978, a ruptured pipe caused an estimated 82,000 gallons of JP-4 fuel to spill onto the ground.</p> <p>The tanks were taken out of service and closed in 1985. The area is currently an open field used as part of an obstacle course by the Marine Corps.</p>	<p>During the IAS team site visit in 1983, no evidence of the spill was found.</p> <p>A Site Assessment was conducted between 1989 and 1991. Four new and six existing monitoring wells were sampled to characterize the extent of contamination from fuel spills. Groundwater and soil samples have been collected and analyzed for benzene, toluene, ethyl-benzene, and xylenes (BTEX).</p> <p>Groundwater: Benzene was detected at 840 ppb above EPA's maximum contaminant level (MCL).</p>	<p>MCCDC Quantico removed some of the product that was released immediately after it occurred, removing fuel that had soaked into the ground near the tanks. The actual amount of fuel recovered was not reported in the site documents.</p>	<p>The Underground Fuel Storage Area does not pose a current or future public health hazard because the spilled fuel has dispersed into the soil, groundwater, and surface water at concentrations that do not pose a health concern.</p> <p>The spill may have resulted in groundwater and surface water contamination for a period of time after the spill occurred. However, the impact on the environment appears to have been limited since evidence of the spill was not apparent during the IAS site visit conducted in 1983, 5 years after the spill.</p>
Camp Barrett Disposal Area (Site 8)	<p>Camp Barrett Disposal Area is a 5-acre site located in the south central portion of Quantico.</p> <p>This site was reportedly used for domestic waste, construction debris, waste oil and solvents from Camp Barrett. Approximately 560 tons were disposed here annually. Open burning of the waste occurred about three times per week during the 1960s. The remaining unburned material was bulldozed into trenches.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site. No sampling was conducted at this site.</p>	<p>No corrective activities were initiated at this site.</p>	<p>Camp Barrett Disposal Area does not pose a public health hazard because the materials that are at the landfill are not hazardous and are not accessible.</p>



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Camp Goettge Disposal Area (Site 9)	<p>This is a two-acre site located in the northern edge of Camp Goettge, at the far western portion of MCCDC Quantico. This disposal area was used from 1950 through 1960 for wastes generated from the camp.</p> <p>Approximately 140 tons per year of trash were disposed of at this site. Open burning of the waste materials reportedly occurred about three times per week and unburned materials were buried in trenches.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site. No sampling was conducted at this site.</p>	<p>No corrective activities were initiated.</p>	<p>Camp Goettge Disposal Area does not pose a public health hazard because the materials that are at the landfill are not hazardous and are not accessible</p>
Camp Upshur Disposal Area (Site 10)	<p>This 3-acre site is located in the northwest corner of MCCDC Quantico. This disposal area was used from 1950 through 1972 for wastes generated from Camp Upshur.</p> <p>Approximately 280 tons per year of trash were disposed of at this site. Open burning of the waste materials reportedly occurred 3-4 days per week and unburned materials were buried in trenches.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site. No sampling was conducted at this site.</p>	<p>No corrective activities were initiated.</p>	<p>Camp Upshur Disposal Area does not pose a public health hazard because the materials that are at the landfill are not hazardous and are not accessible.</p>

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Rifle Range Disposal Area (Site 11)	<p>This is a half-acre site located in the central portion of MCCDC Quantico.</p> <p>The site was used to dispose of trash from the rifle range area between 1960 and 1972.</p> <p>Approximately one and one-half tons per year of trash was disposed of at this site.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site.</p> <p>No sampling was conducted at this site.</p>	<p>No corrective activities were initiated.</p>	<p>The Rifle Range Disposal Area does not pose a public health hazard because the materials that are at the landfill are not hazardous and are not accessible.</p>
Gravel Pit (Site 12)	<p>The Gravel Pit is a half-acre site located in the southeastern portion of the base.</p> <p>It was reportedly used during the 1940s and 1950s as a training area by the Fire Department. Approximately 100 gallons per month of waste fuels were burned at the site.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site.</p> <p>No sampling was conducted at this site.</p>	<p>No corrective actions have occurred at the Gravel Pit.</p>	<p>The Gravel Pit does not pose a public health hazard. The IAS team did not detect any evidence of open burning during their site screening investigation and any residuals from fuels that were burned in the pit have been degraded.</p>
1920's Landfill (Site 14)	<p>This landfill is located between Little Creek and Fuller Road in the northeastern portion of the base. The site was used from 1917 through 1920. During this time garbage and waste materials from the base were burned at this site.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site.</p> <p>No sampling was conducted at this site.</p>	<p>No corrective actions have occurred at the landfill.</p>	<p>The landfill does not pose a public health hazard because the IAS team did not identify any hazardous materials at the site.</p>
Air Station Disposal Area (Site 15)	<p>This disposal area is a one-acre site located at the eastern border of the base near the mouth of Abrahams Creek. The site reportedly operated from 1942 through about 1950 as a disposal area for trash and discarded aircraft parts.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site.</p> <p>No sampling was conducted at this site.</p>	<p>No corrective actions have occurred at the disposal area.</p>	<p>The Air station Disposal Area does not pose a public health hazard because the IAS team did not identify any hazardous materials at the site.</p>



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Midway Island Disposal Area (Site 16)	<p>This one-acre site is located in the southeastern portion of the base west of the Midway Island housing area water tower.</p> <p>The disposal area contains discarded automobiles and discarded appliances and debris from homes. The site is closed, however, some unauthorized disposal continues.</p>	<p>The IAS inspection of the site did not identify any hazardous materials at the site. No sampling was conducted at this site.</p>	<p>No corrective actions have occurred at the disposal area.</p>	<p>The Midway Island Disposal Area does not pose a public health hazard because the IAS team did not identify any hazardous materials at the site.</p>

Sources¹:

Fred C. Hart Associates, Inc. 1984 [ID00059-1]; Radian 1987a [ID00060-1]; Radian 1987b [ID00062-1]; Radian 1988 [ID00064-1]; Radian 1991 [ID00150-1]; Radian 1992a [ID00170-1]; Radian 1992b [ID00171-1]; Radian 1992c [ID00172-1]; Radian 1992d [ID00160-1]; Radian 1992e [ID00161-1]; Halliburton NUS 1993a [ID00058-2]; Halliburton NUS 1993b [ID00061-2]; Halliburton NUS 1993c [ID00421-2]; USEPA 1993 [ID00004-2]; US Navy 1994; US Navy 1996 [Hard copy: ROD April 1996]; Tetra Tech 1998 [ID00906-8]; Tetra Tech 2002 [ID00809-10]; Ensafe/Allen, and Hoshell 1994 [ID00869-2]; OHM Corp 1995 [ID00855-4]; OHM Corp 1997 [ID00811-5].

1. Numbers in the brackets under sources represent the document ID number and corresponding location on the Administrative Record CDs. For example –1 for the first reference cited indicates that the document can be found on CD 1 of the Administrative Record.

APPENDIX B: FIGURES

Figure 1: Location and Demographic Map for MCCDC Quantico

INSERT COPY

Figure 2: Site Map of MCCDC Quantico

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Figure 3: Areas of Contamination Identified at MCCDC Quantico

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Figure 4: ATSDR Exposure Evaluation Process

REMEMBER: For a public health threat to exist, the following three conditions must all be met:

- Contaminants must exist in the environment
- People must come into contact with areas that have potential contamination
- The amount of contamination must be sufficient to affect people’s health

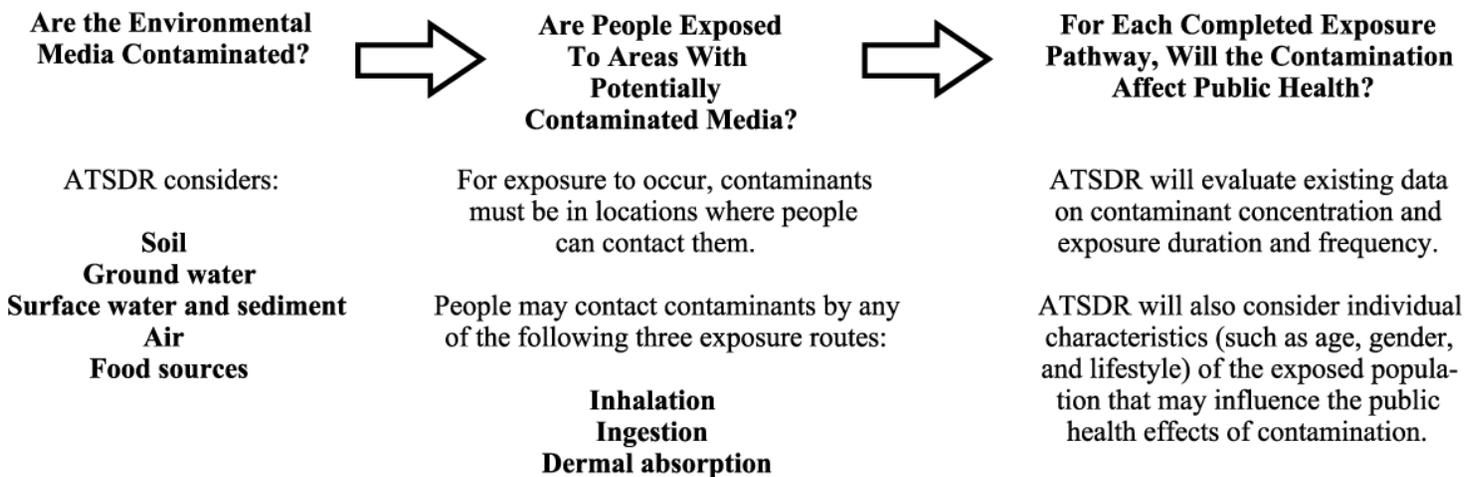
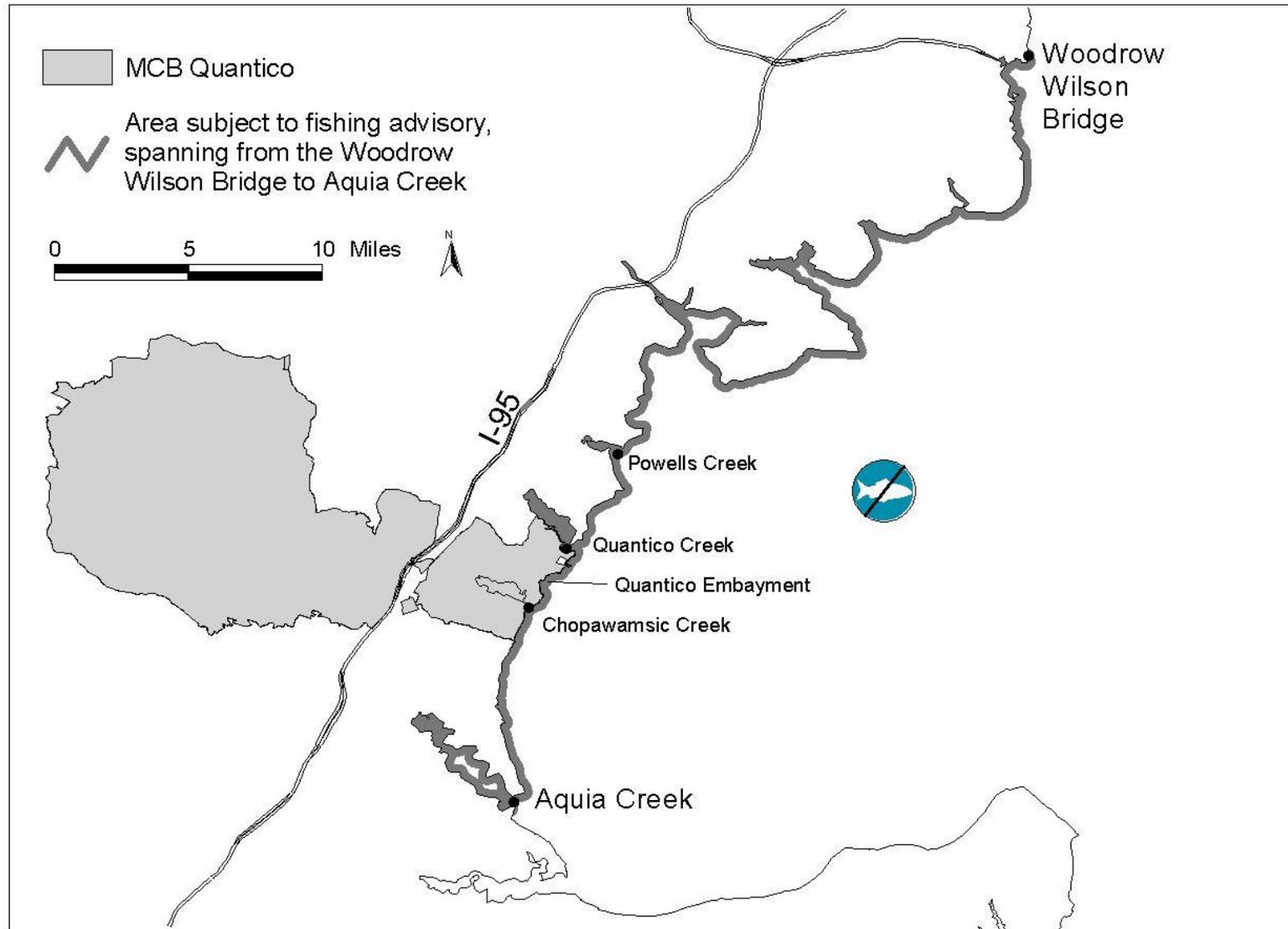


Figure 5: Map of Old Landfill

Figure 6: Areas currently under fishing advisories near MCCDC



Appendix C: Comparison Value Definitions

Comparison values represent media-specific contaminant concentrations that are used to select contaminants for further evaluation to determine the possibility of adverse public health effects. Comparison values are not thresholds for adverse health effects. The conclusion that a contaminant exceeds the comparison value implies the need for further evaluation of site-specific exposure and the public health implications.

Cancer Risk Evaluation Guides (CREGs)

CREGS are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed over their lifetime. ATSDR's CREGs are calculated from EPA's cancer potency factors (CPFs).

Environmental Media Evaluation Guides (EMEGs)

EMEGs are based on ATSDR minimal risk levels (MRLs) that consider body weight and ingestion rates. An EMEG is an estimate of daily human exposure to a chemical (in mg/kg/day) that is likely to be without non-carcinogenic health effects over a specified duration of exposure to include acute, intermediate, and chronic exposures.

Food and Drug Administration's (FDA's) Tolerance Level

A legal limit, currently established by EPA and enforced by FDA, for the maximum amount of a pesticide residue, which may be present in or on a food.

Maximum Contaminant Level (MCL)

The MCL is the drinking water standard established by EPA. It is the maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet. MCLs are considered protective of public health over a lifetime (70 years) for individuals consuming 2 liters of water per day.

Reference Media Evaluation Guides (RMEGs)

ATSDR derives RMEGs from EPA's oral reference doses. The RMEG represents the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects.

Risk Based Concentrations (RBCs)

EPA's RBCs are health-based concentrations of a chemical that a person could be exposed to without resulting in a risk of cancer or other adverse health effects above a specified level of concern. The risk-based concentration is developed from toxicological dose response values, usually selecting the most protective of both cancer toxicological dose response values and non-cancer toxicological dose response values and assumptions about exposure rates.

Appendix D: ATSDR's Process for Evaluating Health Effects

Overview of ATSDR's Methodology for Evaluating Potential Public Health Hazards

To evaluate exposures at Marine Corps Base (MCB) Quantico, ATSDR evaluated available data to determine whether contaminants were above ATSDR's comparison values. For those contaminants that exceeded ATSDR's CVs, ATSDR derived exposure doses and compared them against health-based guidelines. ATSDR also reviewed relevant toxicologic and epidemiologic data to obtain information about the toxicity of contaminants of interest. Exposure to a certain chemical does not always result in harmful health effects. The type and severity of health effects expected to occur depend on the exposure concentration, the toxicity of the chemical, the frequency and duration of exposure, and the multiplicity of exposures.

Comparing Data to ATSDR's Comparison Values

Comparison values are derived using conservative exposure assumptions. Comparison values reflect concentrations that are much lower than those observed to cause adverse health effects. Thus, comparison values are protective of public health in essentially all exposure situations. As a result, *concentrations detected at or below ATSDR's comparison values are not considered to warrant health concern*. While concentrations at or below the relevant comparison value may be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. It cannot be emphasized strongly enough that comparison values are not thresholds of toxicity. The likelihood that adverse health outcomes will actually occur depends on site-specific conditions and individual lifestyle and genetic factors that affect the route, magnitude, and duration of actual exposure, and not an environmental concentration alone.

For this public health assessment, ATSDR evaluated groundwater, surface water, soil, and sediment data collected from source areas at MCCDC Quantico (e.g., the Old Landfill and the Former Rifle Range) as well as fish and shellfish tissue data collected from the Quantico Embayment area. As part of this evaluation, we determined whether people were exposed to contaminant concentrations that exceeded ATSDR's comparison values. Most of the contaminants were detected at or below comparison values and were not evaluated further. Contaminants that were detected above comparison values were evaluated further, prompting ATSDR to estimate exposure doses, as long as a potential completed pathway existed, using site-specific exposure assumptions.

Sources for Health-Based Guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. These toxicological profiles were used to evaluate potential health effects from contamination at MCCDC Quantico. ATSDR's toxicological profiles are available on the Internet at <http://www.atsdr.cdc.gov/toxpro2.html> or by contacting the National Technical Information Service at 1-800-553-6847. EPA also develops health effects guidelines, and in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposure to various substances found in the environment. IRIS is available on the Internet at <http://www.epa.gov/iris>. For more information about IRIS, please call EPA's IRIS hotline at 1-301-345-2870 or e-mail at Hotline.IRIS@epamail.epa.gov.

References

ATSDR (Agency for Toxic Substances and Disease Registry) 2002. Public Health Assessment Guidance Manual (Update). U.S. Department of Health and Human Services. June 2002.

EPA Exposure Handbook [Need Reference]

Appendix E: ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption

The process of taking in a substance. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute

Occurring over a short time [compare with **chronic**].

Acute exposure

Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure**].

Additive effect

A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with **antagonistic effect** and **synergistic effect**].

Adverse health effect

A change in body function or cell structure that might lead to disease or health problems.

Aerobic

Requiring oxygen [compare with **anaerobic**].

Ambient

Surrounding (for example, *ambient* air).

Anaerobic

Requiring the absence of oxygen [compare with **aerobic**].

Analyte

A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study

A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect

A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with **additive effect** and **synergistic effect**].

Background level

An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation

Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study

A study that uses (a) **biomedical testing** or (b) the measurement of a substance [an **analyte**], its **metabolite**, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see **exposure investigation**].

Biologic monitoring

Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake

The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing

Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota

Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden

The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP

See **Community Assistance Panel**.

Cancer

Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk

A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen

A substance that causes cancer.

Case study

A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study

A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number

A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system

The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see **Comprehensive Environmental Response, Compensation, and Liability Act of 1980**]

Chronic

Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure

Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

Cluster investigation

A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)

A group of people, from a community and from health and environmental agencies, who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)

Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration

The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant

A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect

A disease or injury that happens as a result of exposures that might have occurred in the past.

Dermal

Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact

Contact with (touching) the skin [see **route of exposure**].

Descriptive epidemiology

The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit

The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention

Measures used to prevent a disease or reduce its severity.

Disease registry

A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD

United States Department of Defense.

DOE

United States Department of Energy.

Dose (for chemicals that are not radioactive)

The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)

The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship

The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media

Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

EPA

United States Environmental Protection Agency.

Epidemiologic surveillance

The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Epidemiology

The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure

Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Exposure assessment

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation

The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching), and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

Exposure registry

A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study

A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)

A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds

Training sessions for physicians and other health care providers about health topics.

Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**].

Half-life ($t_{1/2}$)

The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard

A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)

The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste

Potentially harmful substances that have been released or discarded into the environment.

Health consultation

A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education

Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion

The process of enabling people to increase control over, and to improve, their health.

Health statistics review

The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard

The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation

The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

In vitro

In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with **in vivo**].

In vivo

Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with **in vitro**].

Lowest-observed-adverse-effect level (LOAEL)

The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring

A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism

The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite

Any product of **metabolism**.

mg/kg

Milligram per kilogram.

mg/cm²

Milligram per square centimeter (of a surface).

mg/m³

Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration

Moving from one location to another.

Minimal risk level (MRL)

An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Morbidity

State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality

Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen

A substance that causes **mutations** (genetic damage).

Mutation

A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)

EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard

A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)

The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard

A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)

A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica

A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure

The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)

A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb

Parts per billion.

ppm

Parts per million.

Prevalence

The number of existing disease cases in a defined population during a specific time period [contrast with **incidence**].

Prevalence survey

The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention

Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period

An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session

An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action

A list of steps to protect public health.

Public health advisory

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)

An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.**

Public health statement

The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting

A public forum with community members for communication about a site.

Radioisotope

An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide

Any radioactive isotope (form) of any element.

RCRA [See Resource Conservation and Recovery Act (1976, 1984)]

Receptor population

People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD)

An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry

A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

Remedial Investigation

The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)

This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA

RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD

See **reference dose**.

Risk

The probability that something will cause injury or harm.

Risk reduction

Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication

The exchange of information to increase understanding of health risks.

Route of exposure

The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

Safety factor [see **uncertainty factor**]

SARA [see **Superfund Amendments and Reauthorization Act**]

Sample

A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size

The number of units chosen from a population or environment.

Solvent

A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination

The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an **exposure pathway**.

Special populations

People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder

A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics

A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance

A chemical.

Substance-specific applied research

A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's **toxicological profiles**. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund Amendments and Reauthorization Act (SARA)

In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water

Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Surveillance [see **epidemiologic surveillance**]

Survey

A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

Synergistic effect

A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see **additive effect** and **antagonistic effect**].

Teratogen

A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent

Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile

An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology

The study of the harmful effects of substances on humans or animals.

Tumor

An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Other glossaries and dictionaries:

Environmental Protection Agency
<http://www.epa.gov/OCEPAt/terms/>

National Center for Environmental Health (CDC)
<http://www.cdc.gov/nceh/dls/report/glossary.htm>

Final Release, MCCDC Quantico



National Library of Medicine:

<http://www.nlm.nih.gov/medlineplus/dictionaries.html>

Appendix F: Exposure Dose Calculations and Assumptions

Deriving Exposure Doses

ATSDR derived exposure doses for those contaminants that were detected above ATSDR's comparison values or did not have comparison values. Exposure doses are expressed in milligrams per kilogram per day (mg/kg/day). When estimating exposure doses, health assessors evaluate chemical concentrations to which people could be exposed, together with the length of time and the frequency of exposure. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. Where possible, ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several conservative exposure assumptions to estimate exposures for on-base and off-base residents and recreational users.

The following equation was used to estimate exposure to contaminants in fish/shellfish tissue:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

- C: Average concentration in fish/shellfish tissue (ppm)
- IR: Ingestion rate: adult = 25 grams per day (0.025 kg/day); child = 13 grams per day (0.013 kg/day)^a
- EF: Exposure frequency, or number of exposure events per year of exposure: 350 days/year^b
- ED: Exposure duration, or the duration over which exposure occurs: adult = 30 years; child = 6 years
- BW: Body weight: adult = 70 kg; child = 17 kg
- AT: Averaging time, or the period over which cumulative exposures are averaged (6 years [child] or 30 years [adult] × 365 days/year for non-cancer effects; 70 years × 365 days/year for cancer effects)

^a The ingestion rate represents standard ingestion rate assumptions used by EPA [EPA Exposure Factors Handbook, August 1997] 95th percentile of freshwater fish consumption.

^b The exposure frequency of 350 days per year represents EPA's standard dose calculation assumptions. ATSDR used this EF as a worst-case scenario with the assumption that an individual or individuals are relying on fish from the Quantico Embayment area for purposes of subsistence (i.e., primary source of dietary nutrition). ATSDR is not aware of subsistence populations in the Quantico Embayment area and acknowledges that the exposure frequency of 350 days per year is highly conservative. However, the 350-day EF assumption will be used until fish consumption survey data becomes available.

Using Exposure Doses to Evaluate Potential Health Hazards

ATSDR analyzes the weight of evidence of available toxicologic, medical, and epidemiologic data to determine whether exposures might be associated with harmful health effects (non-cancer and cancer). As part of this process, ATSDR examines relevant health effects data to determine whether estimated doses are likely to result in harmful health effects. As a first step in evaluating non-cancer effects, ATSDR compares estimated exposure doses to conservative health guideline values, including ATSDR's minimal risk levels (MRLs) and EPA's reference doses (RfDs). The MRLs and RfDs are estimates of daily human exposure to a substance that are *unlikely* to result in non-cancer effects over a specified duration. *Estimated exposure doses that are less than these values are not considered to be of health concern.* To maximize human health protection, MRLs and RfDs have built in uncertainty or safety factors, making these values considerably lower than levels at which health effects have been observed. The result is that even if an exposure dose is higher than the MRL or RfD, it does not necessarily follow that harmful health effects will occur.

For carcinogens, ATSDR also calculates a theoretical increase of cancer cases in a population (for example, 1 in 1,000,000 or 10^{-6}) using EPA's cancer slope factors (CSFs), which represent the relative potency of carcinogens. This is accomplished by multiplying the calculated exposure dose by a chemical-specific CSF. Because they are derived using mathematical models, which apply a number of uncertainties and conservative assumptions, risk estimates generated by using CSFs tend to be overestimated.

If health guideline values are exceeded, ATSDR examines the health effects levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to describe the disease-causing potential of a particular chemical and to compare site-specific dose estimates with doses shown in applicable studies to result in illness (known as the margin of exposure). For cancer effects, ATSDR compares an estimated lifetime exposure dose to available cancer effects levels (CELs), which are doses that produce significant increases in the incidence of cancer or tumors, and reviews genotoxicity studies to understand further the extent to which a chemical might be associated with cancer outcomes. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

Calculating Recommended Maximum Consumption Rates for Fish and Shellfish from the Quantico Embayment

ATSDR derived maximum recommended consumption rates for fish and shellfish. ATSDR used site-specific information about the frequency and duration of exposures. In cases where site-specific information was not available, ATSDR applied several conservative exposure assumptions to estimate exposures.

The following equation was used to calculate the recommended consumption rates for fish/shellfish from the Quantico Embayment:

$$\text{Recommended Maximum Consumption} = \frac{\text{SV} \times \text{BW} \times 365 \text{ days/year}}{\text{AC} \times \text{MS}}$$

where:

- SV: Health-based screening value (mg/kg/day)¹
- BW: Body weight: adult = 72 kg; child = 16 kg (1-6 years old)
- AC: Average concentration (mg/kg) – ATSDR assumed ingestion of average contaminant concentrations detected in each of the species sampled²
- MS: Meal Size – For all species, a single seafood meal was assumed to be 0.228 kg (approximately 8 oz) for adults and 0.114 kg (4 oz) per meal for children.

¹ ATSDR used health-based screening values in the determination of maximum consumption rates for non-cancer outcomes. The Health Protection Value (HPV) of 0.05 ug/kg/day was assumed for total PCBs (Anderson 1993). The ATSDR Minimum Risk Level of 0.5 ug/kg/day was assumed for DDT, which is similar to the EPA reference dose for this contaminant. Based on the HPV value of 0.05 ug/kg/day, an adult could eat one [8 oz] meal per month of fish or shellfish with PCB concentrations up to 1 ppm in raw fish “fillet” or 6 “whole” fish meals per year.

² Average contaminant concentrations were used because they represent realistic exposures to contaminants detected in fish from the Quantico Embayment.

Reference:

Anderson, H.A., Amrhein, J.F., Shubat, P. and Hesse, J. Protocol for a Uniform Great Lakes Sports Fish Consumption Advisory. September 1993.

Appendix G: Site Summary Report, MCCDC Quantico, October 1994

Final Release, MCCDC Quantico



Appendix H: Health Consultation, MCCDC Quantico, February 1996

Appendix I: Response to Public Comment

ATSDR released the draft public health assessment for public comment during the period March 26 – April 30, 2004. The document was available in the information repositories at the John Musante Porter Memorial Library, Chinn Park Regional Library, and the Natural Resources and Environmental Affairs Branch on MCCDC Quantico. Announcements in the local media accompanied release of the draft.

ATSDR received comments and provides the following response:

Comment: The “Exposure Situation Summary Table” on page 22 states that an assessment of asbestos and lead in family housing units had been conducted. The public health assessment and the exposure comments within the table do not address whether the housing occupants were exposed to asbestos.

Response: ATSDR has updated the table and narrative to include discussion of asbestos in family housing.